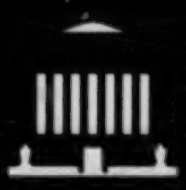

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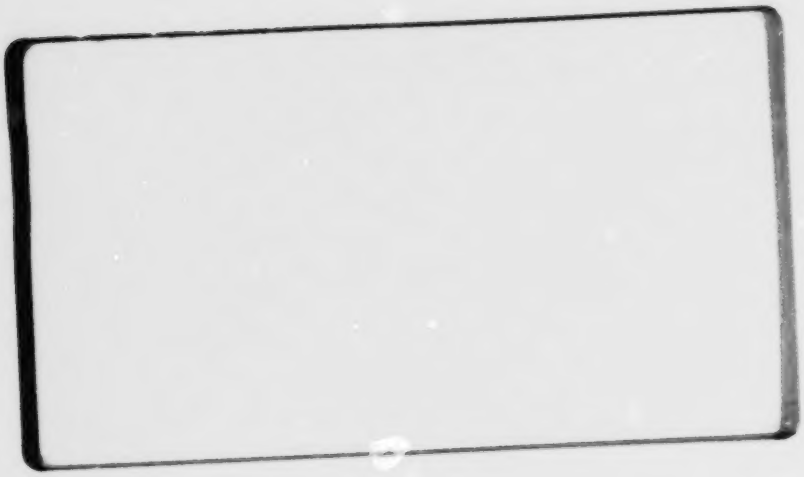

July 1983

Technical Report 38

RESPONSES OF VARIOUS ECONOMETRIC MODELS TO SELECTED POLICY SHOCKS

Brian O'Reilly
Graydon Paulin
Philip Smith

Summary of a seminar held in Ottawa in July, 1982.

The views expressed in this report are those of the authors; no responsibility for them should be attributed to the Bank of Canada or the Department of Finance.

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As with other undertakings of this sort, this conference involved a large number of people. Not all of them will be mentioned here, but their help is nevertheless gratefully appreciated. First and foremost of those to be explicitly acknowledged are the modellers, both for their active and professional participation on the seminar day and also for their cooperation in preparing for that day and subsequently in preparing the write-ups for distribution. Initial support for holding a Comparative Models Seminar was provided by Don Drummond and Phil Smith of the Department of Finance and by the administrative committee, chaired by Bill White, of the Research Department at the Bank of Canada. J.-P. Voyer of the Department of Finance ensured that his colleagues were kept abreast of the latest developments in all aspects of the preparations for the seminar and, in turn, made sure that their concerns and suggestions were passed on to the modellers and to those of us at the Bank. The actual seminar day benefited from the introductions provided by J.P. Aubry and Dennis Featherstone. The chairmen of the various sessions, Dennis Featherstone, Bill White and Pat Grady, helped to establish an atmosphere conducive to a productive exchange of ideas while adhering to a very tight schedule. Participants in the seminar are listed in an appendix.

CONFERENCE PAPERS

QFS

THE QFS RESPONSE TO VARIOUS FISCAL, MONETARY AND EXCHANGE RATE SHOCKS

Heather Robertson, Department of Finance

RDXF

THE RESPONSE OF THE RDXF MODEL TO SELECTED POLICY SHOCKS

Bruce Rayfuse, Bank of Canada

CHASE

SELECTED MODEL SHOCKS

Leo de Bever and Colin Tener, Chase Econometrics Canada

DRI

THE DATA RESOURCES OF CANADA MODEL: ALTERNATE SIMULATION EXPERIMENTS

William Empey and Percy Thadaney, Data Resources of Canada

FOCUS

THE RESPONSE OF FOCUS TO VARIOUS MONETARY POLICY, FISCAL POLICY AND EXCHANGE RATE SHOCKS

Joan Head and Peter Dungan, Institute for Policy Analysis

TIM

THE RESPONSE OF THE INFORMETRICA MODEL TO SELECTED POLICY SHOCKS

Alexander Cullen, Elizabeth Ruddick and Michael McCracken, Informetrica Ltd.

CANDIDE

AN ANALYSIS OF THE MAJOR DYNAMIC PROPERTIES OF CANDIDE MODEL 2.0

Ross Preston and P.S. Rao, Economic Council of Canada

SAM

THE RESPONSE OF SAM TO SOME POLICY SHOCKS

David E. Rose and Jack G. Selody, Bank of Canada

MACE

ENERGY AND THE NATIONAL ECONOMY: AN OVERVIEW OF THE MACE MODEL

John F. Helliwell, Robert N. McRae, Paul Boothe, and Tim Padmore, University of British Columbia

ABSTRACT

In July, 1982 a seminar was held in Ottawa to compare the responses of nine major econometric models to a previously specified set of shocks to the Canadian economy. At the seminar, which was sponsored by the Bank of Canada and the Department of Finance, participants presented the results of their simulations and discussed the reasons for differences among their projections. The simulations chosen were relatively standard because different types of models were involved and because modellers had to provide their own resources.

The monetary policy shocks entailed two reductions in short-term interest rates (100 and 500 basis points), a 1 per cent reduction in the level of the money supply and a 1 percentage point reduction in the growth of money. The fiscal policy shocks embodied two government non-wage expenditure shocks ($1 and $5 billion in $1982), a personal income tax cut ($1 billion in 1982 adjusted over time to proxy a reduction in federal personal income tax rates), and a corporate income tax reduction ($1 billion in 1982 modelled as reduction in federal corporate tax rates) and were done under the assumption of a non-accommodating monetary policy. The two exchange rate shocks involved simulating a 10 per cent permanent depreciation of the Canadian dollar: one via lower domestic interest rates and expanding money supply, the other under the assumption of an exogenous shock but with the exchange rate remaining endogenous.

To give readers an overview of the conference as a whole, this report provides cross-model comparisons of all the simulation results and summarizes the discussion sessions. Introductory remarks and the list of participants in the seminar are provided in appendixes.

RÉSUMÉ

En juillet 1982 s'est tenue à Ottawa, sous les auspices de la Banque du Canada et du ministère des Finances, une conférence visant à comparer les réactions de neuf grands modèles de l'économie canadienne à un ensemble de chocs préalablement spécifiés. Les participants y ont présenté les résultats des simulations qu'ils avaient effectuées, puis ils ont examiné les causes des différences existant entre leurs projections. Les exercices de simulation choisis étaient classiques, parce que les modèles en cause étaient de types différents et que les constructeurs devaient utiliser leurs propres ressources.

Les chocs de politique monétaire comprenaient deux réductions des taux d'intérêt à court terme (l'une de 100 points de base et l'autre de 500 points de base), soit une réduction de 1 % du niveau de la masse monétaire et une réduction de 1 point de pourcentage du rythme de croissance de la masse monétaire. Les chocs de politique budgétaire comprenaient deux variations des dépenses publiques non salariales (l'une de 1 milliard de dollars, l'autre de 5 milliards, toutes deux en dollars de 1982), une réduction de l'impôt sur le revenu des particuliers (1 milliard de dollars en 1982, ajusté sur longue période pour tenir compte d'une réduction des taux d'imposition des particuliers au niveau fédéral), et une réduction de l'impôt fédéral sur le revenu des sociétés (1 milliard de dollars en 1982, considéré comme une réduction des taux d'impôt fédéral sur les bénéfices des sociétés). L'hypothèse sous-jacente à ces chocs était celle de l'application conjointe d'une politique monétaire rigide. Deux chocs de taux de change ont été retenus : une dépréciation permanente du dollar canadien de 10 % s'effectuant par le truchement d'une réduction des taux d'intérêt canadiens et d'une expansion de la masse monétaire, et une dépréciation de 10 % attribuable à un choc exogène maintenu, mais où le taux de change reste néanmoins endogène.

Le présent rapport offre une vue d'ensemble de cette conférence. Il présente des comparaisons entre les modèles et entre les différents résultats obtenus à partir des exercices de simulation et contient un résumé des séances de discussion. Les observations préliminaires faites à la conférence et la liste des participations sont présentés en annexe.

INTRODUCTION

Over the last decade, a number of institutions have built econometric models of the Canadian economy. Because the methodologies and assumptions chosen have varied with the objectives of the model builders, the projected response of the Canadian economy to any given change in circumstances has often seemed to depend on which model was being considered. To find out how and why some or all of the nine major econometric models differ from each other, the Bank of Canada and the Department of Finance held a one-day seminar in July, 1982 for a group of interested researchers (see Appendix B for a list). At the seminar, participants presented the responses of their models to specified monetary policy, fiscal policy and exchange rate shocks, and discussed the results. The simulations chosen for the exercise were relatively standard ones, so as to accommodate the different types of models and to ease the tasks of individual modellers. This report gives an overview of the conference, compares the results of the simulations and summarizes the discussions that took place during the day.

The following section contains a description of the shocks performed, a comparison of model responses, and cross-model summary tables for all the shocks. The last two sections give an account of the discussions held during the day. These discussions allowed modellers to exchange views on their experiences with particular aspects of modelling, to address apparent differences in results, and to indicate the overall approaches they took towards modelling. The first discussion addressed such issues as incorporating long-run properties, modelling real-financial linkages, "crowding out" and handling supply side shocks. In the second discussion session, the participants focussed on the question of the adequacy of current models for producing useful policy advice. There was general agreement that even if a model was built solely for short-term forecasting purposes, it was likely to be used in policy

simulations. Given this, some of the modellers asserted that the best approach was to incorporate as much of accepted theory as possible. Others believed that different models were required for different purposes.

After the seminar, the presentation papers were collected in a looseleaf volume together with the opening remarks and summaries of the model responses and the discussion sessions. The volume, entitled Seminar on Responses of various Models to Selected Policy Shocks, is publicly available and can be obtained from the Bank of Canada.

COMPARISON OF MODEL RESPONSES, WITH CROSS-MODEL SUMMARY TABLES

The intent of this section is to compare the responses of the nine models listed in the table of contents to various monetary policy, fiscal policy, and exchange rate shocks. In the discussions of the results, some attempt will be made to indicate a general framework for considering the model responses. However, there are sufficient differences among the models and in the modellers' views of how the shocks should be implemented and interpreted that the results presented here cannot be used by themselves as an indication of the likely effect of various policy initiatives. An additional caution has to do with the ongoing modification of the models: their current versions may differ significantly from those used in this exercise.

We begin by outlining the shocks requested and then discuss the responses of the various models to monetary policy, fiscal policy and exchange rate shocks.

THE SIMULATIONS REQUESTED FOR THE COMPARATIVE MODELS SEMINAR

The ten simulations initially requested comprised a personal income tax reduction, a corporate income tax reduction, two increases in government spending, two reductions in interest rates, reductions in the level and the growth rate of the money supply, and two exchange rate depreciations. Modellers were asked to conduct the simulations over the period 1982 to 1991 with, except where noted, the money supply exogenous and the exchange rate flexible. Moreover, federal government deficit changes were to be financed by changed levels of debt. All shocks were to be viewed as permanent.

Modellers were also encouraged to add to their model "usual practice" simulation rules but to strive for consistency across simulations. Below, the required simulations and their detailed specifications as originally requested are outlined. In

addition, for each simulation an indication of some of the alternative interpretations suggested by individual modellers is given where applicable. The cross-model summary tables begin on page 45.

LIST OF SHOCKS

1 **Personal Income Tax Reduction (Shock 1 in summary tables)**

- A lump-sum $1 billion gross reduction in federal personal income taxes in 1982, no effect on provincial income tax collections;
- Growing over time with personal income in an attempt to proxy a reduction in personal income tax rates.

Alternatives Considered by Some of the Modellers

(a) an unanticipated reduction
- for models based on a permanent income hypothesis interpreting the shock this way means that only current disposable income changes initially.

(b) a "fully anticipated" tax cut
- for models based on a permanent income hypothesis, the tax cut immediately affects permanent income.

(c) marginal tax rates constant or not?
- the revenue change suggested could be achieved in a number of ways and the responses of some models are particularly sensitive to the manner of implementation.

2 **Corporate Income Tax Reduction (Shock 2 in summary tables)**

- a reduction in federal corporate income taxes achieved by a reduction in the federal corporate tax rate;
- amounting to $1 billion in 1982, changing over time with taxable corporate profits.

Alternative Considered by Some of the Modellers

Are marginal rates constant or not? Is the shock to be viewed as a lump sum effect or are capital costs affected (and hence investment)?

3 Government Spending (Shocks 3 and 5 in summary tables)

- a $1 and $5 billion increase in federal government spending on current non-wage goods and services, growing over time with their deflators;
- and all prices endogenous.

Alternative Considered by Some of the Modellers

A pure fiscal policy experiment using model reaction functions versus the fiscal experiment accompanied by financing through money creation or bond sales (as requested).

4 Interest Rate Reduction (Shocks 4 and 6 in summary tables)

- a 100 and a 500 basis point reduction in short-term interest rates achieved by appropriate changes to add factors,
- but all interest rates and the money supply endogenous in the simulation, and
- if the reduction in short-term interest rates is achieved other than through a change to the 90-day commercial paper rate, the following term structure should be imposed:

	90-day Commercial Paper Rate	90-day Treasury Bills	1- to 3-Year Gov't Bonds	10-Year Gov't Bonds
Basis Points	100	90	75	20

Alternatives Considered by Some of the Modellers

(a) Some modellers interpreted the requested simulation as a money demand shock or a downward shift in the money demand functions and noted that in some cases this requires, for implementation, assumptions about the changes in the composition of the portfolio of financial assets held by the personal sector and the configuration of the term structure. Nevertheless, for most of the results reported here, the actual shock implemented can be interpreted as a change in the money supply.

(b) Initially the SAM modellers chose to assume that the authorities wanted to lower the real rate of interest by 100 basis points so that the differential with the

world real rate is lowered by that amount. For the SAM model this story can be made equivalent to the nominal rate shock request at least in the long run by assuming no change in the target growth of money or planned steady state inflation. In the SAM model, the imperfect substitution between assets gives policy-makers an instrument other than money supply to alter interest rates. However, this approach was not feasible for the 500 basis point reduction since it implies negative nominal rates. Subsequently another shock (see SAM write-up) was provided to be more comparable with the evolving consensus interpretation of this shock.

(c) Lower nominal rates 100 basis points everywhere through shifts of bond and money supplies.

5 Money Supply Level Reduced by One Per Cent (Shock 7 in summary tables)

- maintained for each year throughout the entire simulation period, interest rates endogenous.

6 Money Supply Growth Rate Reduced by One Percentage Point (Shock 8 in summary tables)

- maintained for each year throughout the entire simulation period, interest rates endogenous.

Alternative Considered by Some of the Modellers

Implement through lowering growth rate of target rather than actual money.

7 Exchange Rate Depreciation (Shocks 9a and 9b in summary tables)

- a permanent 10 per cent depreciation of the Canadian dollar (against the United States dollar or an index of world currencies).

a) - invert the exchange rate equation to solve for short-term interest rates consistent with the new value of the exchange rate;

- money supply endogenous

b) - from the control result calculate the add factors necessary to depreciate the exchange rate by 10 per cent.
   - input these add factors and rerun the model;
   - exchange rate and interest rates endogenous;
   - money supply at control.

In Table 1 an asterisk indicates which of the requested shocks were performed by the participating modellers. Modellers did additional shocks to clarify certain properties of their models or to indicate the responses to more specific interpretations of the requested shocks, and readers are referred to the detailed write-ups, available in a separate volume, for discussions of these. Furthermore, some simulations were done or redone after the seminar; the results here incorporate these so as to to compare the most current versions of the models. As

Table 1
INDEX OF MODEL SIMULATIONS
(As Numbered in the Summary Tables)

	1	2	3	4	5	6	7	8	9a	9b
QFS	*	*	*	*	*	*	*	*	*	*
RDXF	*	*	*	*	*	*	*	*		*
CHASE	*	*	*	*						
DRI	*	*	*	*	*	*	*	*	*	*
FOCUS	*	*	*	*	*		*	*	*	
TIM	*	*	*	*	*	*				*
CANDIDE 2.0	*	*	*	*	*	*	*	*	*	*
SAM	*	*	*	*	*		*	*	*	*
MACE	*	*	*	*	*	*	*	*	*	*

indicated above, the interest rate shocks for some of the models are just variants on the money supply level shock or vice versa because of the manner of implementation.

The magnitude of the various responses and the speed with which they occur might depend on the size of the shock, although market restraints can impose limits on what it is reasonable to do. A more important source of non-linearity, as some modellers remarked during the course of the discussion sessions on the seminar day, is the degree of tightness or slack already in the economy at the time when the shocks are imposed. The responses presented in the cross-model summary tables (starting on page 45) relate only to the first point, shocks of different magnitudes.

REDUCTION IN SHORT-TERM INTEREST RATES

Two interest rate reduction shocks, 100 and 500 basis points, were asked for, the second in order to examine the responses for non-linearities. To maximize the comparability of responses across models a term structure was suggested since all models do not have the same short-term rate. Almost all of the modellers implemented this shock as a money supply shock[1] and imposed several simulation rules to generate their results. These simulation rules and the model responses are discussed after the next subsection, which presents a broad characterization of one way of viewing the transmission mechanism between an interest rate reduction and the expenditure and price responses. By examining model responses relative to this framework, we want to provide readers with information sufficient to decide which models might merit further in-depth investigation, given their particular interests.

---

1. In the MACE model the implementation of the shock is closer to an interest rate reduction resulting from a one-time shift in the money supply level than the nominal interest rate shock used by the other modellers.

Transmission Mechanism

A lower interest rate leads to a fall (from what it otherwise would have been) in the uncovered interest rate differential between Canada and the United States. This results in a depreciation of the Canadian dollar (from what it would have been) relative to the United States dollar. The lower value of the dollar has a direct effect on prices; it also makes Canadian exports more attractive abroad and imports relatively more expensive in the Canadian market. This improvement in the trade balance raises Canadian domestic production, causing producers to expand investment spending plans (the acceleration effect). In addition, lower interest rates stimulate investment plans (particularly residential investment) through a decrease in the rental price of capital and through lower mortgage interest rates. These influences increase output and employment, and the resultant effects on disposable income eventually raise consumption spending even if in the near term the lower levels of interest income lead to a decrease in consumption spending. Moreover, lower interest rates may stimulate durables consumption directly, or indirectly as a result of higher residential investment.

The stronger output resulting from higher external and domestic demand is followed by an increase in hiring plans relative to what would have happened had interest rates not been lowered. The stronger labour market environment strengthens wage demands. A combination of higher wages and tighter rates of capacity utilization lead to upward price movements, which are partly offset by lower capital costs. In the longer run, lower capital costs and increased investment spending will raise capacity output and reduce some or all of the pressure on utilization rates. But in the medium run, the higher prices resulting from the relative tightening in capacity utilization are incorporated in expectations and trigger a wage, price, exchange rate spiral. Additionally, or alternatively, the higher money supply growth may affect inflation expectations. These

heightened expectations are then factored into labour's wage bargaining plans and raise prices still further. To the extent that an inflationary spiral is unleashed, real interest rates are further lowered and the process described in the preceding paragraph is exacerbated.

The behaviour of the wage, price, exchange rate sector can shed some light on the accelerationist questions raised by J.-P. Aubry in his introductory remarks (see page 77). There, he identified several conditions as being necessary to get the pure accelerationist result from the experiment where the unemployment rate is shocked above or below its natural rate. They were:

> The price level has to be a homogeneous function of degree one with respect to the sum of all costs; each cost has also to be a homogeneous function with respect to other costs or other prices; and the exchange rate has to be a homogeneous function of degree one with respect to domestic prices or costs.

For those models that were simulated under both shocks (QFS, RDXF, DRI, TIM, CANDIDE 2.0 and MACE) the output and price responses appear to be essentially linear.[2] Thus, for the sake of brevity, the discussion here focusses on the model responses to the 100 basis point reduction in nominal interest rates. Two sets of tables are relevant for comparing model responses to the interest rate reduction. In the cross-model summary tables, which start on page 45, Shock 4 and Shock 6 provide 1st, 3rd, 5th and 10th year responses for selected economic variables. In Table 2, which starts on the next page, selected expenditure components are ranked in terms of their contribution to the shock-minus-control per cent change in real gross national expenditure in the 1st, 3rd, 5th and 10th years of the

---

2. This characterization may be more apparent than real, since relatively small differences for aggregate variables may mask larger differences for some components.

Table 2

HIERARCHY OF RESPONSE (AS RELATIVE CONTRIBUTION TO CHANGE IN REAL GNE) TO A REDUCTION OF 100 BASIS POINTS IN SHORT-TERM INTEREST RATES
Shock-Minus-Control as Percentage of Control (Ranking)

	QFS				REMF				CHASE			
Expenditures (Constant dollars)	Year 1	Year 3	Year 5	Year 10	Year 1	Year 3	Year 5	Year 10	Year 1	Year 3	Year 5	Year 10
Consumption	-.1	-.0	-.2	-.3	.0	.0	-.1	-.1	-.1	-.3	-.3	-.4
Durables	-.1	.0	-.6	-.5	.1(5)	.3(6)	-.1	-.3	.0	-.3	-.4	-.6
Other	-.1	-.0	-.1	-.2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Government Expenditures	.0	.0	.0	.0(5)	.0	.0	.0	.0	.0	.0	.0	.0
Private Fixed Investment					.3	1.3	.7	.2				
Machinery and Equipment	.0(5)	.9(4)	.6(3)	-.1	.4(4)	1.5(4)	.8(4)	.3(4)	.4(4)	.5(4)	.4(4)	.5(5)
Non-Residential Construction	.0	.4(6)	.6(4)	.4(4)	.2(6)	1.0(5)	.6(5)	.0	.1(6)	.2(5)	.1(5)	.1(6)
Residential Construction	.2(4)	1.4(5)	.1(5)	-.5	3.8(3)	5.0(1)	4.7(2)	2.9(2)	3.4(3)	5.4(2)	5.2(2)	5.1(3)
Change in Inventories ($ Billion)	.26(1)	.32(1)	.02(6)	.08(3)	-.01	.01(7)	-.01	.01(5)	[1]3.7(5)	-2.7	-7.2	11.4(4)
Exports	.2(2)	1.0(2)	1.3(1)	1.2(1)	.3(2)	.5(2)	.4(3)	.4(3)	.2(2)	.4(3)	.5(3)	1.0(2)
Imports	.0	.5	.1	-.3	-.2	.1	-.2	-1.3	-.2	-.3	-.5	-.6
Net Exports ($ Billion)	.06(3)	.14(3)	.38(2)	.60(2)	.15(1)	.14(3)	.26(1)	.84(1)	[1]4.1(1)	8.3(1)	15.2(1)	86.3(1)
Final Domestic Demand	-.0	.1	-.0	-.1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Total GNE	.2	.5	.3	.2	.3	.6	.5	.6	.2	.2	.3	.5
Income and Employment												
Wage Rate	.0	.6	1.5	3.6	.0	.9	2.3	5.0	.1	.8	1.4	3.0
Employment	.1	.8	.5	.3	.1	.5	.4	.2	.1	.2	.1	.0
Disposable Personal Income (Level)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
($ Billion) (%)	-.1	.9	1.5	3.1	-.0	.9	1.8	4.0	.0	.3	.7	1.9
Productivity (Real GNP/Employee)	.1	-.3	-.3	-.1	.2	.0	.1	.4	.2	.0	.1	.4
Corporate Profits Before Taxes	4.9	3.7	5.6	10.6	2.9	4.5	5.1	9.0	4.5	2.4	3.0	5.9
Prices and Cost												
Unit Labour Costs	.1	.8	1.6	3.5	.1	1.1	2.4	5.0	n.a.	n.a.	n.a.	n.a.
Exchange Rate (Can$/US$)	.02	.04	.05	.07	.01	.03	.04	.07	[1]1.2	1.7	2.1	3.9
Consumer Price Index	.2	1.0	1.7	3.4	.2	1.0	2.0	4.3	.1	.7	1.1	2.5
GNE - Price	.1	.9	1.7	3.5	.1	1.0	2.1	4.5	.1	.8	1.2	2.8
Terms of Trade (Total)	-.6	-1.1	-1.3	-1.6	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Money Supply (M1)	1.6	3.5	4.2	6.0	1.0	3.3	5.4	8.3	1.4	2.6	3.7	5.9

[1] % instead of levels

TABLE 2
(continued)
HIERARCHY OF RESPONSE (AS RELATIVE CONTRIBUTION TO CHANGE IN REAL GNE)
TO A REDUCTION OF 100 BASIS POINTS IN SHORT-TERM INTEREST RATES
Shock-Minus-Control as Percentage of Control (Ranking)

Expenditures (Constant dollars)	DRI				FOCUS				TIM			
	Year 1	Year 3	Year 5	Year 10	Year 1	Year 3	Year 5	Year 6	Year 1	Year 3	Year 5	Year 10
Consumption	-.2	-.3	-.3	.0	.0	.9	3.0	4.3	-.3	-.5	-.4	-.2
Durables	-.2	-.3	-.2	.1	.1	2.6(5)	6.4(7)	8.0(6)	-.6	-.9	-.8	-.6
Other	n.a.	n.a.	n.a.	n.a.	.0	.5(6)	2.2(5)	3.5(5)	-.3	-.4	-.3	-.1
Government Expenditures	-.1	-.7	-.9	-.5	.0	.0	.0	.0	-.0	.1	.1	.1
Private Fixed Investment					1.3	7.0	16.7	19.8	.6	1.4	1.9	1.4
Machinery and Equipment	.0	.3(5)	.5(5)	.4(4)	1.0(3)	9.0(1)	23.3(1)	25.4(1)	.1(5)	1.2(3)	1.8(3)	1.5(3)
Non-Residential Construction	.0	.5(4)	.6(4)	.1	1.5(1)	6.2(2)	13.0(2)	16.5(2)	.2(4)	1.6(2)	2.2(2)	1.5(4)
Residential Construction	1.3(3)	1.3(3)	1.2(3)	2.3(3)	1.4(4)	4.4(7)	9.7(3)	13.7(3)	2.6(1)	1.6(6)	1.5(6)	1.0(6)
Change in Inventories ($ Billion)	-.02	.07	.04(6)	-.01	.04(5)	.33	.69(6)	.69(7)	.09	.09(4)	.11(4)	.04(5)
Exports	.3(2)	.9(2)	.9(2)	.4(2)	.4(2)	2.3(3)	4.2(4)	4.6(4)	.1(3)	.2(5)	.3(5)	.5(2)
Imports	-.5	-.8	-.7	-.2	.2	1.3	3.0	3.0	-.7	-.9	-1.0	-1.3
Net Exports ($ Billion)	.25(1)	.66(1)	.66(2)	.30(1)	.05(6)	.27(4)	.25	.46	.30(2)	.44(1)	.59(1)	.89(1)
Final Domestic Demand	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Total GNE (2)	.1	.1	.3	.2	.4	2.4	6.0	7.6	.2	.4	.7	.8
Income and Employment												
Wage Rate	.0	.5	1.0	.8	.4	4.2	15.3	23.6	.1	-.2	-.5	-.7
Employment	.0	.2	.2	.1	.2	2.3	5.3	6.3	.1	.2	.3	.3
Disposable Personal Income (Level)	-.28	.70	1.60	2.09	1.22	18.04	73.43	118.90	-.68	-2.71	-4.38	-8.07
($ Billion) (%)	n.a.	n.a.	n.a.	n.a.	.5	5.7	18.7	27.4	n.a.	n.a.	n.a.	n.a.
Productivity (Real GNP/Employee)	.1	.1	.1	.1	.1	.1	.7	1.2	.2	.2	.4	.5
Corporate Profits Before Taxes	.8	3.4	3.1	.9	4.1	21.8	45.7	54.3	4.0	3.6	3.3	2.6
Prices and Cost												
Unit Labour Costs	-.0	.4	1.0	.8	.2	4.0	14.4	21.9	-.0	-.3	-.7	-1.0
Exchange Rate (CanS/US$)	.01	.03	.03	.01	.02	.12	.30	.40	.01	.01	.01	.00
Consumer Price Index	.1	.6	.7	.3	.6	5.4	15.2	21.1	.1	-.3	-.7	-1.0
GNE - Price	-.1	.5	.8	.4	.5	5.0	15.6	22.7	.2	-.3	-.7	-1.0
Terms of Trade (Total)	n.a.	n.a.	n.a.	n.a.	-.5	-1.8	-2.8	-2.8	n.a.	n.a.	n.a.	n.a.
Money Supply (M1)	.3	.8	1.0	1.0	4.6	10.3	22.9	30.7	n.a.	n.a.	n.a.	n.a.

Table 2
(continued)
HIERARCHY OF RESPONSE (AS RELATIVE CONTRIBUTION TO CHANGE IN REAL GNE)
TO A REDUCTION OF 100 BASIS POINTS IN SHORT-TERM INTEREST RATES
Shock-Minus-Control as Percentage of Control (Ranking)

Expenditures (Constant dollars)	CANDIDE 2.0				SAM - Some M Endogeneity				SAM - Target Supply Shift			
	Year 1	Year 3	Year 5	Year 10	Year 1	Year 3	Year 5	Year 10	Year 1	Year 3	Year 5	Year 10
Consumption	-.2	-.1	.1	.0	.6(1)	.7(1)	.6(1)	.1(1)	.2(2)	.2(1)	.0	-.1
Durables	-.5	-.1	.2(6)	.1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Other	n.a.	n.a.	n.a.(4)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Government Expenditures	.0	-.0	-.1	-.1	[1]-.4	-.1	-.1	.1(2)	[1]-.3	.0	.0	.0
Private Fixed Investment	.1	.5	1.0	.6	-.0	-.1	-.2	-.2	.0	-.1	-.2	-.2
Machinery and Equipment	.0	.3(5)	1.0(3)	.6(3)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Non-Residential Construction	.0	.5(3)	1.2(2)	.6(2)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Residential Construction	.3(3)	.8(4)	.7(5)	.5(5)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Change in Inventories ($ Billion)	.02	.0	.03	-.02	.40(2)	.12(2)	.06(2)	-.00	.37(1)	.06(2)	.02(1)	.02(2)
Exports	.1(2)	.2(2)	.2	.1(4)	[2]-.2	-.6	-.7	-.5	[2]-.1	-.1	-.1	-.1
Imports	-.4	-.7	-.4	-.3	[2].9	1.1	.9	-.3	[2].2	.1	-.1	-.3
Net Exports ($ Billion)	.16(1)	.34(1)	.24(1)	.19(1)	[2]-.31	-.47	-.45	-.06	[2]-.16	-.04	-.0	.06(1)
Final Domestic Demand	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Total GNE	.0	.3	.4	.2	.4	.1	-.0	-.1	.2	.1	-.0	-.1
Income and Employment												
Wage Rate	-.0	.6	.8	.4	[3]-.2	-.7	-.9	-1.4	[3]-.3	-.4	-.4	-.3
Employment	-.0	.0	.1	.0	-.0	-.1	-.1	-.1	-.1	-.0	.0	-.0
Disposable Personal Income (Level)	n.a.	n.a.	n.a.	n.a.	1.17	4.58	10.05	17.62	-1.2	-.6	.1	.4
($ Billion) (%)	-.2	.2	.3	-.2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Productivity (Real GNP/Employee)	.0	.2	.3	.2	.4	.2	.1	-.0	.3	.1	-.0	-.1
Corporate Profits Before Taxes	3.9	3.7	3.3	-.4	[4]2.29	3.91	5.32	8.52	[4].97	1.21	1.28	1.77
Prices and Cost												
Unit Labour Costs	-.0	.3	.5	.2	.6	2.6	5.4	10.4	.1	.4	.8	1.4
Exchange Rate (Can$/US$)	.01	.01	.01	.00	.00	.02	.04	.06	.00	.00	.01	.01
Consumer Price Index	.2	.4	.4	-.1	.9	3.4	6.4	12.1	.4	.8	1.3	1.7
GNE - Price	.2	.4	.5	.0	.6	2.8	5.8	11.2	.2	.6	1.1	1.6
Terms of Trade (Total)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Money Supply (M1)	1.2	2.1	2.1	1.1	[5]4.7	5.3	6.4	8.3	[5].4	.2	.1	.1

[1] Non-wage government expenditure.
[2] Non-energy.
[3] Labour's after-tax wage.
[4] Level, not per cent.
[5] Base money.

Table 2
(continued)
HIERARCHY OF RESPONSE (AS RELATIVE CONTRIBUTION TO CHANGE IN REAL GNE)
TO A REDUCTION OF 100 BASIS POINTS IN SHORT-TERM INTEREST RATES
Shock-Minus-Control as Percentage of Control (Ranking)

	MACE			
Expenditures (Constant dollars)	Year 1	Year 3	Year 5	Year 10
Consumption	.0	.1(3)	.2(2)	.4(2)
Durables	n.a.	n.a.	n.a.	n.a.
Other	n.a.	n.a.	n.a.	n.a.
Government Expenditures	.0	.0	.0	.0
Private Fixed Investment	.5(2)	.9(2)	.6(4)	.9(3)
Machinery and Equipment	n.a.	n.a.	n.a.	n.a.
Non-Residential Construction	n.a.	n.a.	n.a.	n.a.
Residential Construction	n.a.	n.a.	n.a.	n.a.
Change in Inventories ($ Billion)	-.05	-.05	.09(3)	-.04
Exports	-.0	-.4	-.6	-.3
Imports	-.6	-1.4	-1.0	-1.0
Net Exports ($ Billion)	.20(1)	.39(1)	.24(1)	.37(1)
Final Domestic Demand	n.a.	n.a.	n.a.	n.a.
Total GNE	.2	.5	.4	.6
Income and Employment				
Wage Rate	-.0	.1	.5	1.2
Employment	.1	.2	.2	.2
Disposable Personal Income (Level)	.1	1.1	2.9	10.7
($ Billion) (%)	n.a.	n.a.	n.a.	n.a.
Productivity (Real GNP/Employee)	.2	.3	.3	.4
Corporate Profits Before Taxes	.4	1.5	2.1	2.9
Prices and Cost				
Unit Labour Costs	-.1	.1	.5	1.0
Exchange Rate (Can$/US$)	.01	.01	.01	.02
Consumer Price Index	n.a.	n.a.	n.a.	n.a.
GNE - Price	-.1	.2	.6	1.2
Terms of Trade (Total)	n.a.	n.a.	n.a.	n.a.
Money Supply (Base Money)	.1	.2	.6	1.4

simulation, and information is provided on income, employment, prices, and costs. Since the ranking was done using only the limited information submitted, there is a slight risk that the placements are not exact. However, the general conformity of models with the framework sketched above can be immediately ascertained and thus candidates can be identified for in-depth examination, depending on the interests of the reader. The next section provides some indication of simulation rules imposed on the various models that are particularly relevant to the interest rate shock.

Simulation Rules

In the QFS and RDXF models exogenous price variables were endogenized through the use of simulation rules. For the former, food and shelter prices were structured as cost mark-up rules on various inputs using the 1976 Statistics Canada Input-Output weights, while in RDXF the farm price of agricultural products was constrained to move, on average over four quarters, with the exchange rate. Moreover, the QFS modellers adjusted their model with a technical relation to ensure that interest payments and receipts moved in a consistent manner across all sectors. The FOCUS model was simulated in its "flexible" price mode with the offset coefficient (-0.753) on the long-term flows set to zero and the equation for provincial and municipal net new issues abroad exogenized. The first change reflected the FOCUS modellers' belief that a short-term effect continued too much into the long term while for the second adjustment it was argued that the specification seemed too interest-rate sensitive. In both the CANDIDE 2.0 and TIM models the results from their exchange rate equations were adjusted to bring about a larger depreciation, at least during the initial period. For the CANDIDE 2.0 model the very small coefficient on the interest rate differential deriving from a period of estimation prior to 1975 was not considered appropriate while in the TIM model write-up it is pointed out that the flexible exchange rate rule, which is a

function of the current account balance, does not adequately capture the direct interest rate influence. The adjustment in CANDIDE 2.0 was to depreciate the Canadian dollar by 1.5 per cent during the first two years for every 100 basis point sustained reduction in Canadian short-term rates, with the exchange rate endogenous. In TIM a proportional rule, 1 cent for each 100 basis point change in short-term interest rates, was also used but only in the first year. Nominal government expenditures were kept at control by the DRI modellers for the financial shocks.

Model Responses

For the aggregate output and price variables (constant dollar GNE and the GNE deflator) shown in Shock 4 of the summary tables, the model responses on impact, both in the medium term and in the longer run, show substantial differences. Furthermore the model results do not indicate a consensus view on the trade-off between wage and/or price inflation and the unemployment rate gap (see the chart opposite).

The shock minus control as per cent of control difference in output on impact ranges from no change in CANDIDE 2.0 to a near .4 per cent change in SAM[3] and FOCUS. The subsequent dynamic behaviour differs substantially among models, with the output response peaking on impact for SAM, in year 3 for OFS and DRI, in year 5 for CANDIDE 2.0 and increasing steadily for all the other models (until year 6 for FOCUS).[4] Yet, excluding the two outlying models (FOCUS and SAM) there is a broad agreement that the effect of a 100 basis point reduction in the 90-day

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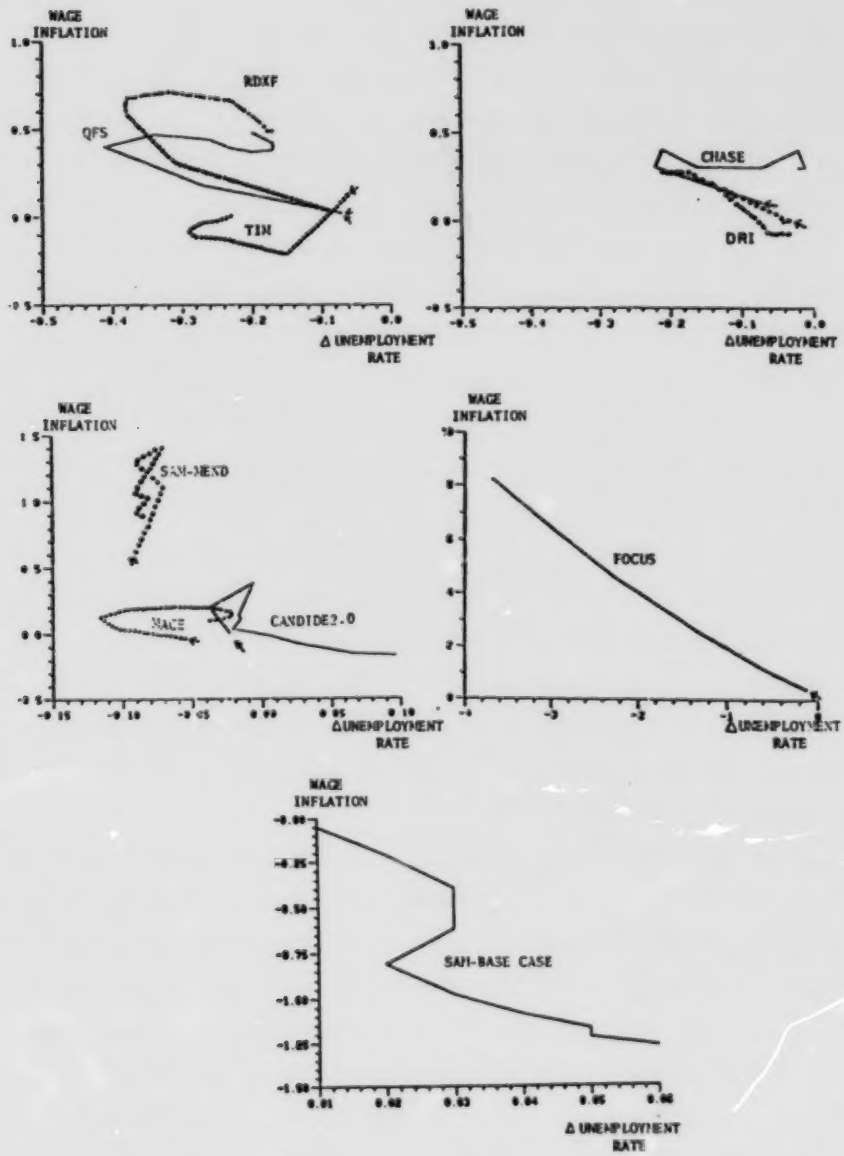
3. Unless otherwise indicated the discussion of SAM model results focusses on the "Some M-Endogeneity" case.

4. The FOCUS model would not simulate past the middle of year 7 because of the interaction of such factors as the real interest rate effects in non-residential investment, a pronounced 'J-curve' response to exchange rate changes, the mobility of international capital and the 'flexible' price mode sensitivity to demand shifts.

RESPONSE OF WAGE INFLATION AND UNEMPLOYMENT
TO A REDUCTION IN NOMINAL INTEREST RATES
(SHOCK MINUS CONTROL)



1. Two shocks are provided for SAM. The shock labelled SAM-MEND is the 100 basis points nominal interest rate reduction attained through shifts of bond and money supplies. The second shock, SAM-BASE CASE, is probably more comparable in the sense of manner of implementation with the results of the other models.

commercial paper rate yields on average 0.4% higher real output (.38% in year 3, .45% in year 10).

Price level responses across models, as measured by the shock minus control as a per cent of control decline on impact in MACE and DRI, rise 0.1 to 0.2 per cent in all the other models except FOCUS and SAM, where the increases are 0.5 and 0.6 per cent respectively. Except for DRI, CANDIDE 2.0 and TIM, the per cent deviation of the GNE deflator from control grows steadily over the simulation period with the largest difference from control exhibited by FOCUS. The difference in the inflation rate in year 10 varies from a high increase of 7.1 percentage points (year 7) in FOCUS through .8 percentage points in SAM, a grouping between .3 to .5 percentage points for CHASE, QFS and RDXF, to .1 percentage point in MACE and declines for TIM, DRI and CANDIDE 2.0. For all of the models, though, the price equations contain cost mark-ups on domestic and external costs and in some models (SAM, QFS, MACE, FOCUS, DRI) demand/supply imbalance variables. Almost all of the models have a variant of an expectations augmented Phillips curve with the form of the price expectations-term differing across models--three of the models incorporate money supply growth directly (FOCUS, CANDIDE 2.0 and SAM) into the expectations process.

The DRI and CANDIDE 2.0 models have the peak response in price levels in year 5, after which the percentage difference from control reduces in each year. As noted earlier, the CANDIDE 2.0 exchange rate equation is adjusted to give more of a depreciation in the first two years but remains endogenous. The CANDIDE 2.0 modellers indicate that, given the high elasticity of capital flows to financing requirements in Canada and the low elasticity of the interest rate differential in the exchange rate equation, the activity effect ultimately dominates the substitution effect. Thus, the depreciation peaks in year 1 and subsequently withers away leading to relatively muted price and output responses. The negative price responses in TIM after year 1, where the model is adjusted to give more depreciation, are

attributed by the TIM modellers to unit capital costs. They also note that unit labour costs accentuate the decline in prices as the lower CPI puts downward pressure on wages (through the expectations components of these equations).

This property of TIM is particularly obvious if the trade-off between wage inflation[5] and the difference between shock and control for the unemployment rate is examined. As the unemployment rate gap is widening (the unemployment rate moves further below its control values) wage inflation is actually falling relative to control, attaining its peak decline in the third year of the shock before moving back towards the control inflation rate, which is reached in year 10 with the unemployment rate still below control. From year 6 onward CANDIDE 2.0 also indicates a falling wage inflation rate with the unemployment rate rising above its control value in year 8 and increasing for the rest of the simulation period.

Except for FOCUS the remaining models all seem to be returning toward their control levels of the unemployment rate with the QFS, RDXF, and CHASE model results suggestive of a permanent wage inflation effect. Both the MACE and SAM results indicate that wage inflation may return to its control value and for SAM, where results out to year 20 exist, wage inflation is only slightly above control then and the unemployment rate is marginally above its control value. Given the way the shock appears to have been implemented in MACE (see footnote 1), its response should not be unexpected.

From the Shock 4 summary table it may be seen that the impact exchange rate depreciation varies from no change in the SAM model up to 2 cents in the QFS and FOCUS models. By the

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5. Calculated as the first difference of the shock minus control as per cent of control change in the wage rate for all models except SAM where the wage inflation response is provided. Note that the chart contains two graphs for SAM. The discussion in the text focusses on the interest rate reduction shock, but some idea of the versatility of SAM might be gained by looking at the results based on the money supply growth rate shock.

tenth year (recall that the FOCUS model would not simulate past the middle of the seventh year), the QFS, RDXF, SAM, and CHASE models exhibit the largest depreciations partly as a result of the worsening relative price performance in Canada and partly because the interest elasticities in their exchange rate equations were lower in the short run than in the long run.

Table 2 shows that, on impact, net exports is one of the top two contributors to the per cent shock-minus-control change in real GNE for all models except QFS, FOCUS, and SAM; but even in the first two models, exports alone is one of the top two contributors. Next to the external sector, residential construction expenditures are the most common channel for interest rates to directly influence total spending in year 1. The FOCUS model has a strong impact response for all components of fixed investment, partly attributable to the real interest rate terms in the non-residential investment equations. Stronger non-residential investment induces more imports and thus explains why net exports are not as important in terms of relative contribution in FOCUS. The QFS and SAM models show relatively strong inventory responses on impact, reflecting the importance of the user cost and real interest rate terms respectively in determining desired inventories. Moreover, SAM is the only model in which consumption expenditures increase on impact, reflecting the forward-looking behaviour in the household sector, with the real rate effect on households' discounting of future returns increasing human wealth in this shock. These higher levels of expenditures lead to more imports contributing, along with the drop in non-energy exports, to a decline in real non-energy net exports.

In the medium and long term all of the models except SAM do show an increase relative to control in business fixed non-residential investment attributable to the workings of the accelerator mechanism, with the direct effects through capital cost terms exerting greater effects in some models than in others (MACE versus RDXF, for example). The direct effect of interest

rates through the residential construction sector continues to be important in most models over the simulation period. On a contribution basis, though, net exports, where they were important to begin with, retain their relatively high ranking over the 10-year simulation period for all models.

None of the models, on the basis of the results shown in Table 2, can be said to conform completely in the dynamic evolution of their responses with the broad picture painted earlier. The most obvious consistent discrepancy is the failure of consumption spending to recover above control despite the anticipated improvement in most models in labour income (based on the wage rate and employment responses). This behaviour reflects the specification of consumption spending as depending on current and lagged real disposable income or on a permanent income measure that is based on lagged income terms. Those models with a wealth variable in the consumption equation (SAM and MACE) do indeed get consumption expenditures moving above control. The FOCUS model results owe more to the real interest sensitivity of capital spending and the resultant feedbacks to disposable income.

MONEY SUPPLY SHOCKS

The money supply shocks--the 1 per cent reduction in the level of the money stock and a 1 percentage point reduction in the annual growth rate--were included so that the homogeneity of model responses could be examined. Shocks 7 and 8 in the summary tables provide a profile of the model responses for selected variables. For most of these models no direct constraints exist to ensure that homogeneity obtains, but in some models the price response appears to be approaching the neutrality result.

A 1 Percentage Point Reduction in Money Growth

The 1 percentage point reduction in money growth causes interest rates in all the models except SAM to increase relative to control with the difference relative to control growing from

one year to the next during the simulation period except for the FOCUS and MACE models. In these two models the shock-minus-control increase in the short-term rate declines and levels off in the medium term before starting to rise again.

The version of the SAM model used for this exercise allowed the target growth rate of the money supply to be reduced, and under the then standard SAM reaction functions this would lead to a reduced target bond supply. The reduced supply relative to demand leads to higher prices for bonds and lower rates. In the FOCUS and MACE models, the strong real-financial links reduce nominal income fairly quickly in the near to medium term so that the interest rate increase required to hold money growth 1 per cent below control eases somewhat.

The results for the models participating in this shock, for the most part, indicate that an increasing portion of the decline in nominal income is attributable to prices. However, if the growth rate of the GNE implicit deflator is focussed upon, two models, CANDIDE 2.0 and DRI, show that after 10 years the rate of inflation is 0.2 per cent greater and less than control respectively. Moreover, those are the two models where nominal interest rates after 10 years of deceleration in monetary growth show the largest increase relative to control. Most of the other models suggest that after 10 years the rate of inflation has been reduced by close to 1 per cent, but that the full equilibrium (lower inflation, lower nominal interest rate, and the unemployment and real exchange rates back to control) has not yet been reached. The SAM model appears to come the closest to the full equilibrium result in the 10-year horizon.

The SAM results show an immediate decline in the nominal and real government bond rates, as the shock is implemented through a joint reduction of target money growth and target bond supplies. (An alternative is provided where bond supply is allowed to compensate for the loss in real government revenue in the short run.) Despite the existence of links between money growth and developments in the price, wage, and foreign exchange rate

sectors, inflation expectations and inflation exhibit a delayed adjustment to the new situation before subsequently overshooting the neutrality result. What distinguishes SAM from most of the other models is that the output response is determined in large part from the supply rather than the demand side. For example, the initial decline in inflation raises desired inventory stocks, which in turn feed through short-run target inventories to actual inventories, and into the price equations to lower the price level. The short-run reduction in real rates also leads to higher desired and actual capital stocks. The near-term declines in financial and human wealth--the former related to lower real supplies of base money, the latter related to a cyclical response to excess capacity in labour and product markets and to higher average tax rates because of loss of liability finance--lead to higher labour supply and steady state output but lower consumption. Consumption is lower not only in the near term but throughout the 10-year simulation horizon; human wealth falls even further below control in the last half of this period as the real discount rate rises, reflecting the overshooting that occurs in SAM. The net effect is for marginally lower real GNE and unemployment rate levels than in the control by year 10 but with no effect on real GNE growth and with growth in the GNE implicit deflator down some 1 1/4 per cent.

The dynamics of the models other than SAM are essentially those alluded to in the section on interest rate reductions but are included here to the extent believed to be required for the exposition. Thus, in QFS, one noteworthy channel for the effect of the continuing increase in nominal interest rates is through a sustained widening of the inventory gap leading to a deceleration of prices and wages such that the homogeneity result is approached in year 10. In RDXF, the interest rates have their largest direct output effects through residential construction; otherwise the channel is through the response of the external side to the exchange rate appreciation and the operation of the accelerator mechanism. The continued small response in the

growth of output in year 10 is ascribed to the sensitivity of the import category "other service payments", and to exchange and interest rate movements. As indicated earlier in this summary, the monetary channel in RDXF is essentially an interest rate channel, and the price/cost response reflects output (the unemployment rate gap in the wage equation for example) and exchange rate movements. Prices respond to the exchange rate via the goods import deflators and to the unemployment rate gap term via the wage equation but do not achieve the homogeneity results in year 10, primarily because of the lags in the response of the exchange rate to rising interest rates.

Recall that the FOCUS model has a fairly strong immediate response to the impact of real interest rates through its fixed investment sector, so that growth of real output falls below control in year 1 and falls fairly continuously afterward with the difference in year 10 registering .4 percentage points. The growth rate of the GNE implicit deflator in year 10 might appear to be indicative that money neutrality holds, except that the FOCUS modellers make specific reference to the non-neutrality property of the money demand equation. The implication of this equation is that the GNE implicit deflator will grow 1.2 per cent more for each 1 per cent increase in money growth, ceteris paribus.

The MACE model has an inventory stock gap measure in its price inflation equation and both an unemployment rate and an output gap measure in its wage inflation equation. Initially, prices rise in the MACE model as long rates increase about one-third as much as short rates, driving up the bundled capital/energy price that enters the output price equation via domestic costs. An additional effect occurs by way of the terms of trade variable in the wage equation. Subsequently the shock-minus-control movement in the inventory gap term and the effect of the increasing appreciation relative to control on world and import price terms dominate to push down the output and absorption prices. Similarly the flow change in output to

vintage-based synthetic supply, the ratio of the natural to the actual unemployment rate term and absorption price inflation all begin to work to push down wage inflation relative to control. By year 10 price inflation is .7 percentage points below its control rate (.8 using the absorption price) with some two-thirds of the decline in nominal income attributable to prices. The per cent shock-minus-control change in the exchange rate in year 10 is still greater than the change in the GNE implicit deflator because the continuing interest rate effects cause portfolio reallocations including some influence on the international allocation of new saving.

The DRI model response for both prices and output appears to be heavily dependent on the trade sector. Falling real net exports throughout the simulation period, reflecting the very strong appreciation of the Canadian dollar, cause an accelerator-type reaction which, with reduced retained earnings, results in falling business fixed non-residential investment. Inventories after year 1 also decline at least partly because of buffering. Consumption and residential construction are above their control levels everywhere as prices fall faster than disposable income (the latter rises in year 1). The behaviour of disposable income reflects, in part, the substantially greater rise in nominal interest rates in the DRI model. Real government current spending on goods and services increases as prices fall since this spending is fixed in nominal terms in the model for this simulation.[6] By year 10, though, output is growing only slightly less than in control. The initial positive price response of the GNE implicit deflator seems attributable to a terms of trade effect as the consumer price index falls below control. Subsequently the GNE implicit deflator drops below control as the growing appreciation of the Canadian dollar due to the ever widening interest differential and weakening economy are passed through to final prices.

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6. This condition is sufficient to prevent attainment of the homogeneity result.

For CANDIDE 2.0 the reduced money supply growth rate leads to continuously rising interest rates and falling real economic activity led by lower net exports. Higher user costs of capital and the accelerator mechanism lower business fixed non-residential investment while higher mortgage rates cause residential construction to fall. The decline in real output is moderated by the rise in consumption expenditures due to the increase in real disposable income as the price fall related to an appreciating Canadian dollar, weaker economic activity (operating through wages) and lower price expectations outweigh the disposable income drop following from the weaker economic activity. By year 10, the wage rate decline is over 1 1/2 times as large as that for consumer prices but higher interest income keeps the fall in disposable income about one-third that of consumer prices. In year 10 some 60 per cent of the decline in nominal GNE is attributable to prices but the inflation rate is actually increasing, with output growth little different from control. This inflation rate performance occurs despite the fact that money supply growth enters the price expectations term used in the wage equation.

A 1 Per Cent Reduction in the Money Supply Level (Shock 7)

The short-term interest rate increase in year 1 to implement the money level shock ranges from virtually zero in SAM to 283 basis points in the DRI model, but with all the models except the DRI model requiring less than a 100 basis point increase to implement the shock. By year 10, four out of the seven models for which this shock was undertaken have their short-term rates little different from their control levels, although the DRI model requires a rise of 124 basis points.

For the homogeneity result to obtain, the money supply level reduction should eventually be entirely reflected in prices and the exchange rate with no effect on real output or interest rates. The time period for this to occur might be longer than

the ten-year simulation period. The percentage shock-minus-control change in the GNE deflator for the QFS, RDXF, FOCUS and SAM models is more or less in the area of the homogeneity result but these and the other models continue to show some real output effects.

The dynamics of the complete model responses for almost all of these models are similar to those outlined earlier. One interesting exception is the SAM model where the shock was implemented by lowering the target level for money, which implied that the target bond issue in this version of SAM was also reduced.

FEDERAL GOVERNMENT EXPENDITURE SHOCKS

Modellers were requested to run two government non-wage expenditure shocks, one of $1 billion and the other of $5 billion. The second was done in order to test for non-linearities. The expenditure shocks were specified to be permanent in real terms, meaning that in current dollar terms they started at $1 billion and $5 billion in 1982 and grew in subsequent years in accordance with an appropriate price index. All modellers provided results for the $1 billion expenditure shock and all except CHASE also provided results for the $5 billion shock.

The money supply was held at control for the purposes of the shock in all models except TIM, where interest rates instead were held at control. Thus, except for the TIM simulation, effects on real GNP and the price level were offset by changes in interest rates such that money demand remained unchanged. The RDXF, FOCUS, and MACE modellers also provided supplementary simulations in which expenditure was increased and monetary policy was accommodating. In the case of the non-accommodated $1 billion expenditure increase, short-term interest rates rise 0 (DRI) to 31 (MACE) basis points in the first year, 1 (DRI) to 42 (MACE) basis points in the second year and 0 (DRI) to 187 (CANDIDE 2.0) basis points in the tenth year (although it should be noted that

the MACE results are for the 1- to 3-year Canada bond yield rather than for short-term paper as in the other models).

The stimulus from added government expenditure operates through the models in textbook fashion. Initially the higher demand gives rise to increased production, greater imports and a drawdown of inventories. The higher production is reflected partly in increased employment of factors of production and partly in short-term productivity gains. Higher employment in turn brings higher labour income and increased consumer spending, although there is some leakage into savings. With a lag, investment is also encouraged via the accelerator. Prices tend to rise as a result of several factors. Smaller output gaps as a result of the increase in demand imply some direct pressure on prices, while reduced labour market slack also leads with a lag to higher wage increases and, via markups, additional pressure on prices. Rising prices tend to increase inflationary expectations, so that the process begins to feed on itself. Money demand tends to increase as higher real demand and higher prices cause a larger demand for transactions balances. However, with the money supply predetermined, interest rates tend to rise to choke off this increase in money demand. After the initial years these interest rate increases begin to have a significant negative impact on demand and production levels.

Table 3 summarizes the main results for the $1 billion federal expenditure shock without monetary accommodation. The results for TIM are omitted from the table because they were only available for a shock with monetary accommodation. The results displayed in the table show considerable diversity among the models. The short-term impacts of the fiscal stimulus on real GNE range from lows of .09 per cent in the first year and .08 per cent in the second year for SAM to highs of .8 per cent and .7 per cent in the two years respectively for CHASE. Six of the eight models have impact multipliers that exceed unity. Inflationary impacts are negligible in the early years for QFS, RDXF and CANDIDE 2.0, and more substantial for CHASE, DRI, FOCUS

Table 3

SUMMARY OF $1 BILLION NON-ACCOMMODATED FEDERAL GOVERNMENT EXPENDITURE SHOCK
Shock-Minus-Control as a Percentage of Control

	QPS			RDXF			CHASE		
	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10
GNE - value	.31	.38	.75	.30	.31	.49	.9	1.2	2.6
- price	-.02	.02	.61	.01	.11	.48	.1	.5	2.6
- volume	.32	.36	.14	.28	.20	.01	.8	.7	.0
Wage rate	.01	.03	.82	.05	.20	.65	.2	.8	3.0
Employment	.18	.48	-.03	.15	.22	-.04	.6	.6	-.4
Profits	3.12	3.29	1.80	1.50	.63	-.03	4.6	2.7	3.4
Federal balance[1]	-.62	-.54	-2.94	-.89	-1.08	-2.42	n.a.	n.a.	n.a.
Interest rate[2]	.12	.14	.33	.10	.26	.17	.2	.3	1.5
Exchange rate (Can$/US$)	.00	.00	.00	.00	.00	.00	-.1[3]	.1[3]	1.3[3]

	DRI			FOCUS			CANDIDE 2.0		
	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10
GNE - value	.36	.67	.89	.49	.83	1.60	.50	.62	1.11
- price	.02	.32	.64	.27	.58	1.67	-.05	.00	.95
- volume	.33	.35	.24	.22	.25	-.06	.55	.62	.17
Wage rate	.02	.14	.68	.14	.42	1.34	.01	.07	1.03
Employment	.16	.28	.17	.15	.30	.12	.28	.38	.25
Profits	1.13	1.98	2.35	2.37	2.37	1.93	2.58	2.57	1.63
Federal balance[1]	-.67	-.55	-1.06	-.35	-.24	-.36	-.67	-.75	-6.72
Interest rate[2]	.00	.01	.00	.11	.18	.35	.17	.24	1.87
Exchange rate (Can$/US$)	.01	.01	.02	.01	.01	.02	.00	.00	.00

	MACE			SAM		
	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10
GNE - value	.31	.42	.54	.21	.31	1.51
- price	.14	.30	.71	.12	.24	1.61
- volume	.18	.13	-.18	.09	.08	-.10
Wage rate	.10	.27	.59	-.15	-.21	-.48
Employment	.06	.10	.07	.00	.01	.02
Profits	.72	.55	.07	n.a.	n.a.	n.a.
Federal balance[1]	-.70	-.73	-2.46	-.50	-.09	-.24
Interest rate[2]	.31	.42	.55	.05	.05	.03
Exchange rate (Can$/US$)	.00	-.01	.01	.00	.00	.01

1 Absolute difference between shock and control, in billions of dollars.
2 Absolute difference between shock and control, in percentage points.
3 ∆ instead of levels.

and MACE, particularly in the second year. Wage rates rise significantly as a result of the shock with all models showing important lags, and profits rise by amounts that vary more or less in accordance with the GNE impacts. Most models show relatively small increases in interest rates in the short term, in the 0-30 basis point range. Exchange rate impacts also appear generally small in the first two years. Finally, it may be noted that the estimated short-term net increase in the federal budget deficit ranges from $.1 billion to $1.1 billion. (The high estimate is from RDXF, where interest rates rise relatively more and thereby significantly affect public debt charges.)

The longer term simulation results are of more questionable value, since many of the models (with the notable exception of SAM and perhaps some of the other annual models) were built with primary attention given the shorter-term dynamics rather than longer-term equilibrium conditions.[7] For what they are worth, the results in Table 3 show some evidence of crowding out in the later years of the simulation. All models except DRI and SAM show interest rates up fairly substantially by the tenth year. Five (RDXF, CHASE, FOCUS, SAM and MACE) show real GNE at or below control by the tenth year, and the other three models show increases in real GNE relative to control that are one-third to two-thirds lower than the increases in the impact years. The cumulative multipliers for the 10-year simulation period are unambiguously positive for all models.

Table 4 provides a summary of the results for the expenditure shock with monetary accommodation that was done by four modellers. The results exhibit extreme differences among models, with FOCUS showing much larger inflationary and real growth responses (so large that the expenditure shock is self-financing by the second year and reduces the federal deficit by

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7. The seminar participants discussed the issue of incorporating desirable long-term properties in econometric models quite extensively. See the reports on the two discussion sessions presented later in this report.

Table 4

SUMMARY OF $1 BILLION ACCOMMODATED FEDERAL GOVERNMENT EXPENDITURE SHOCK
Shock-Minus-Control as a Percentage of Control

	RDXF			TIM			FOCUS		
	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10
GNE - value	.32	.46	1.24	.40	.41	.63	.58	1.25	9.75
- price	.02	.16	1.15	-.05	-.05	.35	.32	.85	8.16
- volume	.30	.30	.09	.46	.47	.28	.26	.40	1.47
Wage rate	.05	.23	1.39	.09	.04	.37	.18	.61	8.47
Employment	.15	.27	-.01	.19	.29	.46	.17	.42	1.17
Profits	1.69	1.47	1.32	2.18	2.10	1.52	2.81	3.95	9.83
Federal balance[1]	-.85	-.84	-1.16	-.92	-1.10	-3.06	-.26	.18	11.77
Money supply	.13	.38	1.24	-.54	-.58	-2.55	.48	1.03	8.00
Exchange rate (Can$/US$)	.00	.00	.02	.00	.00	.00	.01	.02	.11

	MACE		
	Year 1	Year 2	Year 10
GNE - value	.33	.49	1.09
- price	.12	.28	1.07
- volume	.21	.21	.02
Wage rate	.10	.27	.96
Employment	.07	.13	.14
Profits	.78	.73	.99
Federal balance[1]	-.69	-.70	-2.36
Money supply	.10	.20	.72
Exchange rate (Can$/US$)	.00	.00	.01
Interest rate[2]	.22	.27	.33

1 Absolute difference between shock and control, in billions of dollars.
2 Absolute difference between shock and control, in percentage points. The MACE model simulation allowed for partial rather than full monetary accommodation.

almost $12 billion in the tenth year) and TIM showing large induced decreases in the money supply. This shock was not specifically requested from the modellers for the purposes of the seminar, and the present review will not comment further upon it. Nevertheless it is an interesting experiment that readers may wish to pursue in the detailed documentation provided by the individual modellers in the main seminar volume.

As already mentioned, modellers were also asked to run separate simulations of $1 billion and $5 billion government expenditure increases to examine the degree of non-linearity in their models. The results of this exercise are summarized in Table 5. The indication from the aggregates recorded in the table would seem to be that the models are all fairly close to linear, although there clearly may be important non-linearities in comparisons of more disaggregated measures. This general result parallels that noted earlier for the interest rate shocks.[8]

PERSONAL INCOME TAX REDUCTION

Modellers were also asked to simulate a personal income tax reduction by reducing federal personal income taxes by $1 billion in 1982 and continuing the reduction in the years beyond, scaled by the growth in personal income. The shock was intended to simulate a cut in federal tax rates with provincial rates left unaffected. The QFS modellers ran two shocks, one in which the tax cut was "unanticipated" and one in which it was "fully anticipated"; the discussion that follows will focus on the latter shock. The TIM modellers implemented the shock in a way that differed considerably from the others in that adjustments were made to offset the induced impacts on provincial revenues and federal-provincial transfers and the simulation was conducted with an accommodating monetary policy.

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8. The discussion at the seminar on the subject of non-linearities was quite extensive. See the report on the second discussion session, presented later in this report.

Table 5

COMPARISON OF $1 BILLION AND $5 BILLION FEDERAL EXPENDITURE SHOCKS
Ratio of the Impact of the Larger Shock to that of the Smaller Shock

	OPS			RDXF			DRI		
	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10
GNE - value	4.94	5.00	6.05	4.93	4.94	4.65	4.92	4.90	4.90
- price	4.00	7.00	5.97	-1.00	3.36	4.79	5.00	5.00	4.89
- volume	5.03	4.90	6.21	5.36	5.85	-1.00	5.03	4.85	4.92

	FOCUS			TIM[1]			CANDIDE 2.0		
	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10
GNE - value	5.14	5.08	5.11	5.00	5.05	5.49	4.97	4.92	5.66
- price	5.30	5.16	5.11	5.00	4.60	6.00	4.60	25.50	5.44
- volume	4.86	4.76	5.67	4.91	4.89	4.75	4.96	4.85	6.35

	SAM			MACE[2]		
	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10
GNE - value	5.71	6.22	5.02	4.98	4.98	5.13
- price	5.00	5.83	4.91	5.03	5.00	5.19
- volume	6.67	6.50	3.10	4.96	4.89	1.13

1 This comparison is for an expenditure shock with monetary accommodation, whereas the other comparisons in the table are for shocks without monetary accommodation.
2 Partially accommodating monetary policy.

The main results of the personal income tax shock are summarized in Table 6. Short-term impacts on real GNE in the first two years range between .11 per cent (FOCUS, year 1) to .36 per cent (QFS, year 2) for the more comparable models. Longer-term effects on the level of real GNE range from .24 per cent for DRI to -.12 per cent for FOCUS. Only FOCUS shows a significant inflationary impact from the shock in the first year (.15 per cent) and for the second year only three models show an important inflationary effect (FOCUS shows .41 per cent, MACE shows .19 per cent and DRI shows .16 per cent). Estimated short-term impacts on the federal deficit as a result of the $1 billion tax cut range from $.6 billion (QFS, year 2) to $1.2 billion (CANDIDE 2.0, year 2). Most models show interest rates rising 0-30 basis points in the short term. CANDIDE 2.0 has the largest longer-term interest rate response (247 basis points in year 10). Most models exhibit fairly small exchange rate effects.

Table 7 provides a comparison of the government expenditure and personal income tax shocks, viewed from the perspective of the size of policy actions required to attain certain broad macroeconomic objectives. The model results in the table show, for example, that reducing the unemployment rate by one percentage point by non-accommodated fiscal policy actions could require an expenditure increase of $3 billion to $9 billion per year (or $30 billion or more per year if the SAM and MACE results are taken at face value) or a personal income tax cut of between $4 billion and $13 billion per year (or $20 billion or more in the cases of SAM and MACE). The expenditure increase policy works more quickly than the tax cut policy in stimulating growth and reducing unemployment. To cut the price level one per cent below control requires huge expenditure cuts or tax increases if the goal is to be attained in one year. Even over three years, the objective would apparently require policy action of several billion dollars per year. CHASE, FOCUS and SAM suggest that expenditure cuts of somewhat more than $1 billion per year would reduce the price level 1 per cent within three years while DRI,

Table 6

SUMMARY OF $1 BILLION NON-ACCOMMODATED FEDERAL GOVERNMENT PERSONAL INCOME TAX SHOCK
Shock-Minus-Control as a Percentage of Control

	QFS			RDXF			CHASE		
	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10
GNE - value	.28	.39	.89	.19	.31	.62	.1	.2	.5
- price	.00	.03	.66	.01	.08	.57	.0	.0	.3
- volume	.28	.36	.23	.18	.23	.05	.2	.2	.1
Consumption (volume)	.57	.76	.77	.36	.53	.58	.3	.5	.5
CPI	-.02	.01	.57	.05	.15	.59	.0	.1	.4
Personal disp. income	.58	.77	1.36	.55	.77	1.31	.5	.6	1.1
Federal balance[1]	-.69	-.61	-4.07	-.97	-1.14	-3.27	n.a.	n.a.	n.a.
Interest rate[2]	.12	.14	.39	.06	.22	.22	.1	.4	1.8
Exchange rate (Can$/US$)	.00	.00	.00	.00	.00	.01	.0[3]	.1[3]	.2[3]

	DRI			FOCUS			CANDIDE 2.0		
	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10
GNE - value	.12	.41	.91	.27	.60	2.02	.27	.36	1.16
- price	-.06	.16	.67	.15	.41	2.14	-.01	.06	1.12
- volume	.19	.25	.24	.11	.18	-.12	.27	.30	.04
Consumption (volume)	.26	.28	.18	.20	.29	.46	.49	.54	.98
CPI	.04	.20	.71	.19	.45	1.88	.02	.08	1.08
Personal disp. income	n.a.	n.a.	n.a.	.57	.87	2.35	.61	.78	2.58
Federal balance[1]	-.85	-.69	-1.56	-.78	-.74	-1.55	-.89	-1.19	-9.07
Interest rate[2]	.00	.01	.00	.06	.13	.44	.18	.33	2.47
Exchange rate (Can$/US$)	.01	.01	.02	.00	.01	.02	.00	.00	.01

	MACE			TIM[4]			SAM[4]		
	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10
GNE - value	.22	.34	.96	.20	.25	.63	.02	.09	1.04
- price	.08	.19	.90	-.01	.01	.30	.04	.08	1.16
- volume	.14	.15	.07	.20	.24	.33	-.01	.01	-.12
Consumption (volume)	.12	.37	.38	.32	.42	.75	.05	.12	-.07
CPI	n.a.	n.a.	n.a.	.02	.04	.31	.05	.11	1.18
Personal disp. income	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Federal balance[1]	-.80	-.83	-2.60	-.92	-1.14	-3.29	-.65	-.26	-.32
Interest rate[2]	.15	.19	.30	.01	.00	.00	.03	.04	.03
Exchange rate (Can$/US$)	.00	.00	.01	.00	.00	.01	.00	.00	.01

1 Absolute difference between shock and control, in billions of dollars.
2 Absolute difference between shock and control, in percentage points except for CHASE.
3 % instead of levels.
4 The TIM results are not comparable because monetary policy is accommodating and the SAM results are not comparable because of the nature of the model. The QFS results also are not fully comparable because the shock was assumed to be fully anticipated.

Table 7

FISCAL POLICY ACTIONS REQUIRED IN ORDER TO ATTAIN MAJOR MACROECONOMIC OBJECTIVES
Billions of Dollars Per Year

	Reduce Unemployment One Per Cent		Increase Real GNP One Per Cent		Decrease CPI One Per Cent	
	In One Year	Over Three Years	In One Year	Over Three Years	In One Year	Over Three Years
Change in Federal Govt. Expenditures						
QFS	8.6	5.1	3.1	3.0	125.0	-5.2
RDXF	9.1	9.1	3.3	6.1	-14.3	-6.0
CHASE	2.0	2.5	1.3	2.5	-10.0	-1.3
DRI	6.5	5.0	3.0	3.8	-23.8	-3.1
FOCUS	11.4	5.1	3.7	4.3	-3.8	-1.2
TIM[1]	7.2	3.6	2.2	2.3	55.6	-62.5
CANDIDE 2.0	4.1	2.9	1.8	1.7	53.2	-5.1
SAM[1]	166.7	29.4	8.3	14.7	-5.0	-1.4
MACE	25.0	34.5	5.7	20.0	-11.2	-3.9
Change in Personal Income Tax						
QFS	-10.0	-3.7	-3.6	-2.5	-50.0	14.3
RDXF	-16.7	-9.1	-5.6	-5.6	20.0	5.0
CHASE	-33.3	-12.5	-5.0	-5.0	∞	10.0
DRI	-12.5	-6.7	-5.3	-5.3	25.0	3.3
FOCUS	-25.0	-5.9	-9.1	-4.2	5.3	1.3
TIM[1]	-14.3	-6.3	-5.0	-3.7	50.0	14.3
CANDIDE 2.0	-8.3	-5.8	-3.7	-2.7	41.7	5.1
SAM[1]	-100.0	-50.0	100.0	-20.0	20.0	4.2
MACE	-31.3	-21.7	-7.2	-7.8	17.9	4.7

[1] Not comparable to the other models, since the TIM results assume an accommodating monetary policy and the SAM results reflect a number of assumed government reaction functions.

MACE, CANDIDE, QFS and RDXF suggest that cuts of $3 billion to $6 billion would be required. TIM indicates that there is virtually no scope at all for reducing inflation via fiscal policy.

CORPORATE INCOME TAX REDUCTION

The corporate income tax rate reduction shock was done by all nine modellers. The simulation results varied considerably over models, reflecting among other things the different specifications for the business investment equation. Table 8 provides an overview of the model responses to the shock.

Lower corporate tax rates imply changes to the rental cost for capital services and consequent implications for the equilibrium capital-labour ratio. All models show stimulus to business investment in the short run except SAM, which shows very marginal investment declines. After 10 years all models except CANDIDE 2.0, MACE and SAM continue to show substantial investment increases relative to control. Most models also suggest positive impacts on real GNE from the shock, although QFS shows significantly negative real impacts because of strong import leakage and inventory liquidation and CHASE, MACE and SAM show essentially no impact on real GNE in the short term. Several models (DRI, CANDIDE 2.0, QFS) show quite favourable short-term impacts on inflation because of the shock, while the others show very little impact on prices at all. Employment impacts are positive in all models except QFS, and tend to grow larger over time. Interest rates rise in some cases (CANDIDE 2.0 shows increases of 23 and 41 basis points in the first two years and a 384 basis point increase by the tenth year) and they decline in others (notably QFS). Finally, it is worth observing that most models show the net impact on the federal deficit close to or above the initial $1 billion tax cut itself (although FOCUS and SAM provide notable exceptions to this statement).

EXCHANGE RATE DEPRECIATION SHOCKS

The exchange rate shocks were intended to simulate a 10 per

Table 8

SUMMARY OF $1 BILLION CORPORATE TAX SHOCK
Shock-Minus-Control as a Percentage of Control

	QFS			RDXF			CHASE		
	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10
GNE - value	-.26	-.30	-.74	.04	.10	.04	.0	.0	.1
- price	-.09	-.27	-1.33	-.00	.02	.02	.0	.0	-.1
- volume	-.17	-.03	.60	.04	.08	.03	.0	.0	.2
Business investment (volume)	.07	.87	1.68	.35	.65	.14	.1	.6	.9
Employment	-.10	-.11	.18	.02	.07	.01	.0	.0	.0
Federal balance[1]	-1.26	-1.36	-3.68	-1.00	-1.19	-3.20	n.a.	n.a.	n.a.
Interest rate[2]	-.13	-.15	-.41	.01	.06	.02	.0	.0	.0
Exchange rate (Can$/US)	.00	.00	.00	.00	.00	.00	.0	.0	.1

	DRI			POCUS			CANDIDE 2.0		
	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10
GNE - value	-.31	.04	.56	.06	.16	.65	.07	.17	1.04
- price	-.59	-.50	.02	.03	.08	.34	-.12	-.19	1.05
- volume	.28	.54	.54	.03	.08	.31	.19	.36	-.02
Business investment (volume)	.13	.84	2.10	.22	.42	.66	.31	1.15	-1.51
Employment	.09	.32	.36	.02	.07	.23	.08	.16	.20
Federal balance[1]	-.97	-.77	-1.92	-.40	-.60	-3.26	-1.16	-1.17	-12.65
Interest rate[2]	.00	-.01	.00	.01	.04	.14	.23	.41	3.84
Exchange rate (Can$/US)	.01	.01	.03	.00	.00	.01	.00	.00	.01

	MACE			TIM[3]			SAM[3]		
	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10
GNE - value	.01	.04	.23	.05	.20	.69	.00	.03	.13
- price	.01	.02	.28	-.00	-.06	.24	.02	.02	.19
- volume	.01	.01	-.05	.05	.26	.45	-.02	.01	-.06
Business investment (volume)	.02	.05	-.04	.21[4]	.94[4]	1.48[4]	-.01[4]	-.01[4]	-.05[4]
Employment	.00	.01	.03	.02	.10	.30	.00	.00	.00
Federal balance[1]	-.93	-1.10	-3.14	-1.12	-1.27	-3.93	-.52	-.13	-.21
Interest rate[2]	.01	.03	.09	.00	.00	.00	.02	.03	.01
Exchange rate (Can$/US)	.00	.00	.00	.00	.00	.01	.00	.00	.00

1 Absolute difference between shock and control, in billions of dollars.
2 Absolute difference between shock and control, in percentage points.
3 The TIM results are not comparable because monetary policy is accommodating and the SAM results are not comparable because of the nature of the model.
4 Private fixed investment.

cent permanent depreciation of the Canadian dollar. Modellers considered two alternative versions of the shock. In one of these, case A, there was a depreciation of exactly 10 per cent (relative to control) that was engineered by changing domestic interest rates and allowing the money supply to expand. In the other version, case B, there was an exogenous shock of 10 per cent applied to the exchange rate equation with the exchange rate itself remaining endogenous. Six modellers did the first version of the shock (QFS, DRI, FOCUS, CANDIDE 2.0, SAM and MACE) and seven modellers did the second version of the shock (QFS, RDXF, DRI, TIM, CANDIDE 2.0, SAM and MACE).

The case A shock is essentially a monetary shock. The depreciation is put into effect by large reductions in interest rates, accompanied by increases in the money supply. The necessary interest rate reduction to bring about the 10 per cent depreciation differs considerably across models. Thus the results differ among models not only because of differential direct impacts of the depreciation on exports and imports, but also because of differential interest rate declines and varying model responses to lower interest rates (which were discussed earlier in the context of the direct interest rate shocks).

Table 9 reports the main results for the case A simulations. Initial interest rate declines range from 63 basis points (SAM) to 894 basis points (DRI). The QFS, FOCUS and CANDIDE 2.0 models suggest interest rate decreases in a narrower range of 575 to 668 basis points, while MACE indicates a decline of only 82 basis points. Most models show smaller interest rate reductions relative to control in the second year, although MACE shows a moderately larger reduction. By the tenth year of the simulation, only DRI and CANDIDE 2.0 continue to show interest rates substantially below control.

Export volumes are, of course, affected quite strongly by the shock. The degree of their reaction depends on the supply responses of exporting firms which are world price-takers and on the price-elasticity of world demand faced by exporters who have

Table 9

SUMMARY OF 10 PER CENT DEPRECIATION SHOCK ENGINEERED BY MONETARY POLICY (CASE A)
Shock-Minus-Control as a Percentage of Control

	QFS			DRI			FOCUS		
	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10
GNE - value	2.06	4.05	6.40	.52	3.05	3.25	8.58	9.34	10.82
- price	.72	2.37	6.35	-.32	2.18	2.68	5.35	5.89	9.48
- volume	1.33	1.65	.05	.83	.87	.55	3.05	3.26	1.22
Exports (volume)	1.65	3.14	.89	2.31	3.77	3.68	1.44	1.71	-.79
Imports (volume)	.08	1.74	-.38	-3.67	-3.06	-3.32	2.18	.64	-.87
Current account balance[1]	-2.88	-2.23	.37	.00	3.10	8.70	-3.52	-1.69	-.80
Federal balance[1]	1.83	3.35	.54	1.48	3.48	7.53	7.73	6.70	16.88
Interest rate[2]	-5.75	-2.65	-.50	-8.94	-4.20	-9.87	-6.68	7.08	.39
Money supply	11.59	10.91	7.79	5.00	2.90	11.72	39.19	-15.20	8.10
Corporate profits	19.93	18.25	16.95	8.06	14.31	10.98	36.89	16.29	6.00
Unemployment rate[2]	-.54	-1.14	-.09	-.40	-.90	-.23	-1.42	-2.17	-.38

	CANDIDE 2.0			SAM			MACE		
	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10
GNE - value	2.98	4.70	5.40	3.87	5.88	8.18	2.48	4.52	11.44
- price	2.77	3.74	3.94	2.69	4.83	7.41	2.21	3.66	9.53
- volume	.20	.93	1.41	1.14	1.00	.72	.26	.83	1.75
Exports (volume)	.78	1.40	1.64	2.07	2.15	-.89	1.79	.56	1.06
Imports (volume)	-2.99	-4.48	-3.45	-5.92	-4.51	1.36	-4.01	-5.12	.79
Current account balance[1]	3.42	6.83	14.38	-1.34	-1.64	-6.99	.79	3.07	-4.42
Federal balance[1]	4.28	4.19	14.92	-1.13	-4.10	-4.21	-.33	.38	-.06
Interest rate[2]	-5.77	-2.98	-5.19	-.63	-.31	-.24	-.82	-.92	-.20
Money supply	6.60	5.87	-1.54	10.00	10.00	10.00	3.18	5.24	11.02
Corporate profits	39.32	28.74	14.13	n.a.	n.a.	n.a.	5.13	8.58	13.85
Unemployment rate[2]	-.48	-.40	.07	-.12	-.32	.25	-.25	-.45	.05

1 Absolute difference, in billions of dollars.
2 Absolute difference, in percentage points.

downward-sloping demand curves. Given the substantial degree of economic slack in the early years of the control solution, one might expect the response to the shock to be enhanced. The models do show substantial export volume increases, ranging from .78 per per cent (CANDIDE 2.0) to 2.31 per cent (DRI) in the first year and from .56 per cent (MACE) to 3.77 per cent (DRI) in the second year. Import volume responses are highly conditioned by the positive impacts of lower interest rates on the interest-sensitive components of domestic demand, which tend to offset the negative impact of domestic-goods substitution due to the depreciation itself. These two countervailing forces operate differently in the various models with the result that the import response to the shock varies within a wide range: -5.92 per cent (SAM) to 2.18 per cent (FOCUS). All models except QFS and FOCUS show net impacts on import volumes that are negative.

The impacts on the current account balance are quite diverse across the models not only because of varying export pricing assumptions and estimated elasticities of trade volumes with respect to prices but also because of differences in import volumes induced by differential increases in economic activity.

Concerning the estimated net short-term impacts on real GNE, the CANDIDE 2.0, DRI and MACE models provide the smallest responses (less than 1 per cent in the first two years) and the other three models show considerably larger impacts ranging as high as 3.26 per cent in the case of FOCUS. All models except DRI and QFS show substantial immediate pressures on the domestic price level and by the second year the price level responses range between 2.18 per cent (DRI) and 5.89 per cent (FOCUS).

The models agree on the general nature of the corporate profits response to the shock: it is positive and large. Four of the six models also suggest favourable impacts on the federal budget balance, with the estimated impact in the case of FOCUS being especially favourable--reaching $7.73 billion in the initial year of the simulation. Finally, it may be noted that the estimated effects on the unemployment rate are favourable and

Table 10

SUMMARY OF 10 PER CENT DEPRECIATION SHOCK VIA AUTONOMOUS FORCES (CASE B)
Shock-Minus-Control as a Percentage of Control

	QFS			RDXF			DRI		
	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10
GNE - value	.93	2.41	6.44	1.47	2.49	8.93	.57	3.51	4.14
- price	.62	1.95	7.28	.81	2.10	8.52	-.16	2.37	3.42
- volume	.30	.45	-.78	.66	.38	.38	.72	1.12	.70
Exports (volume)	1.56	2.81	.02	3.18	2.27	1.26	2.85	3.90	3.48
Imports (volume)	-.67	-.24	-1.43	-1.21	-1.73	-.25	-4.24	-3.87	-3.57
Current account balance[1]	-2.09	-.11	1.88	2.11	2.74	.04	.42	4.58	10.1
Federal balance[1]	.73	1.51	-4.14	1.03	1.03	-3.72	1.06	3.20	6.69
Interest rate[2]	.61	1.20	2.93	.86	2.42	3.56	.01	.09	.00
Money supply	.00	.00	.00	.61	.29	.09	.00	.00	.00
Corporate profits	4.86	10.26	16.35	14.59	8.12	7.83	9.53	15.14	12.47
Unemployment rate[2]	-.18	-.56	.24	-.29	-.48	-.27	-.39	-.97	-.29

	TIM			CANDIDE 2.0			SAM		
	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10	Year 1	Year 2	Year 10
GNE - value	4.04	5.06	7.18	3.27	3.79	1.25	2.54	3.92	7.96
- price	3.06	3.60	5.57	2.93	3.50	.74	1.84	3.23	8.97
- volume	.95	1.40	1.53	.33	.28	.50	.69	.67	-.93
Exports (volume)	1.54	1.29	.81	.73	1.19	.37	2.43[3]	3.01[3]	.96[3]
Imports (volume)	-4.53	-4.09	-3.79	-1.87	-3.48	-.93	-7.45[3]	-6.51[3]	-2.91[3]
Current account balance[1]	3.08	2.49	5.22	2.09	5.42	3.33	.64	1.29	2.94
Federal balance[1]	3.58	2.82	7.93	2.87	1.95	7.41	-.07	-.91	3.50
Interest rate[2]	.35	.05	.00	-.26	-.09	-5.02	.25	.55	.50
Money supply	-17.67	-21.89	-35.38	.00	.00	.00	.00	.00	.00
Corporate profits	24.11	8.12	.53	31.69	13.53	2.35	n.a.	n.a.	n.a.
Unemployment rate[2]	-.47	-.67	-.99	-.65	-.32	.44	-.03	-.25	.21

	MACE		
	Year 1	Year 2	Year 10
GNE - value	1.97	3.12	4.86
- price	2.70	4.72	10.39
- volume	-.71	-1.53	-5.01
Exports (volume)	1.92	2.39	5.59
Imports (volume)	-1.71	.51	12.08
Current account balance[1]	.20	1.16	-24.92
Federal balance[1]	-.58	-.52	-3.02
Interest rate[2]	2.07	3.37	5.70
Money supply	.00	.00	.00
Corporate profits	3.41	4.08	-1.81
Unemployment rate[2]	-.05	.05	.23

1 Absolute difference, in billions of dollars.
2 Absolute difference, in percentage points.
3 Excluding energy.

generally in the 1/4 to 1/2 percentage point range in the first year and in the 1/2 to 1 percentage point range in the second year. The FOCUS model indicates particularly large unemployment rate reductions of 1.42 and 2.17 percentage points in the first two years.

Table 10 provides the model estimates for the case B simulations where the exchange rate drops 10 per cent via autonomous forces. This shock provides a "purer" indication of the differential model responses to exchange rate changes per se, as interest rate effects are generally much smaller than in the case A shock. Impacts on real GNE are much lower, but the inflationary impacts are broadly similar to those in the other simulation. As for the effects on trade, the export volume responses are little different from those in the case A simulations while the import volume responses are much smaller reflecting the different domestic demand effects due to smaller interest rate reductions.

CROSS-MODEL SUMMARY TABLES

SHOCK 1: A $1 BILLION REDUCTION IN PERSONAL INCOME TAX
(Percentage difference between shock and control)

	QFS	RDXF	CHASE	DRI	POCUS	TIM	CANDIDE 2.0	SAM	MACE
Real GNE (%)									
Year 1	.28	.18	.20	.19	.11	.20	.27	-.01	.14
3	.40	.18	.20	.19	.24	.27	.38	.05	.13
5	.34	.14	.10	.19	.15	.28	.35	.04	.13
10	.23	.05	.10	.24	-.12	.33	.04	-.12	.07
GNE deflator (%)									
Year 1	.00	.01	.00	-.06	.15	-.01	-.01	.04	.08
3	.09	.15	.10	.31	.77	.04	.16	.19	.27
5	.23	.35	.20	.42	1.28	.11	.38	.48	.34
10	.66	.57	.30	.67	2.14	.30	1.12	1.16	.90
Unemployment rate (% level)									
Year 1	-.10	-.06	-.03	-.08	-.04	-.07	-.12	-.01	-.03
3	-.27	-.11	-.08	-.15	-.17	-.16	-.17	-.02	-.05
5	-.16	-.07	-.02	-.13	-.16	-.23	-.21	-.04	-.05
10	-.04	.02	.06	-.14	-.06	-.34	-.17	-.03	-.02
Federal government balance (level) (1) (billions of dollars)									
Year 1	-.688	-.970	-6.9	-.854	-.779	-.924	-.893	-.646	-.795
3	-1.075	-1.450	-8.4	-.847	-.659	-1.308	-1.478	-.483	-.951
5	-1.675	-2.080	-17.9	-1.065	-1.043	-1.780	-2.472	-.343	-1.279
10	-4.071	-3.270	-1549.9	-1.559	-1.549	-3.293	-9.068	-.316	-2.599
Real consumption									
Year 1	.57	.36	.30	.26	.20	.32	.49	.05	.32
3	.85	.55	.50	.24	.41	.48	.73	.19	.40
5	.82	.56	.50	.23	.52	.58	.84	.09	.42
10	.77	.59	.50	.18	.46	.75	.98	-.07	.38
Current account balance (level) (billions of dollars)									
Year 1	-.376	-.370	-.5	-.296	-.276	-.281	-.474	-.007	-.173
3	-.850	-1.040	-.9	-.184	-.722	-.538	-.894	-.136	-.766
5	-.840	-1.440	-1.1	-.182	-.958	-.896	-1.241	-.117	-1.115
10	-.791	-2.570	-.7	-.020	-2.970	-2.120	-2.975	-.105	-2.749

(1) CHASE - percentage difference between shock and control.

SHOCK 2: A $1 BILLION REDUCTION IN CORPORATE INCOME TAX
(Difference between shock and control)

	QFS	RDXF	CHASE	DRI	FOCUS	TIM	CANDIDE 2.0	SAM	MACE
Real GNE (%)									
Year 1	-.17	.04	.00	.28	.03	.05	.19	-.02	.01
3	.12	.03	.00	.49	.13	.37	.47	.01	.01
5	.38	-.00	.10	.50	.15	.39	.53	.04	-.00
10	.60	.03	.20	.54	.31	.45	-.02	-.06	-.05
GNE deflator (%)									
Year 1	-.09	-.00	.00	-.59	.03	-.00	-.12	.02	.01
3	-.41	.03	.00	-.34	.13	-.06	-.23	.04	.05
5	-.74	.08	.00	-.19	.12	.04	-.05	.09	.09
10	-1.13	.02	-.10	.02	.34	.24	1.05	.19	.28
Unemployment rate (% level)									
Year 1	.06	-.01	.00	-.09	-.01	-.02	-.05	-.00	-.00
3	-.01	-.03	-.02	-.35	-.06	-.15	-.18	-.00	-.01
5	-.04	.00	.00	-.36	-.07	-.22	-.29	-.02	-.01
10	-.11	-.00	.01	-.34	-.14	-.23	-.21	.00	-.00
Exchange rate (Can$/U.S.$ - level) (1)									
Year 1	.00	.000	0.0	.01	.001	.000	.001	.000	-.000
3	.00	.000	0.1	.01	.004	.002	.003	.000	-.000
5	.00	.001	0.1	.02	.003	.003	.005	.001	.000
10	-.00	.001	0.1	.03	.008	.005	.010	.001	.004
Current account balance (billions of dollars)									
Year 1	.053	-.140	-.3	-.013	-.097	-.132	-.283	-.088	-.036
3	-.830	-.410	-.5	-.129	-.174	-.667	-.993	-.007	-.210
5	-1.513	-.440	-.6	-.262	-.108	-1.094	-1.581	.028	-.405
10	-2.102	-.830	-.3	-.060	-.622	-1.960	-3.465	.003	-1.097
Nominal investment in machinery and equipment and non-residential construction (level) (billions of dollars)									
Year 1		.21		-.02	.16		.17		
3		.35		1.51	.50		1.13		
5		.21		2.64	.48		1.85		
10		.28		5.98	2.08		-.22		

(1) CHASE - percentage difference between shock and control.

SHOCK 3: A $1 BILLION INCREASE IN FEDERAL CURRENT NON-WAGE EXPENDITURES
(Difference between shock and control)

	QFS	RDXF	CHASE[1]	DRI	FOCUS	TIM[2]	CANDIDE 2.0	SAM	MACE
Real GNE (%)									
Year 1									
3	.32	.28	.8	.33	.22	.46	.55	.09	.18
5	.38	.14	.4	.27	.24	.43	.60	.07	.05
10	.31	.07	.2	.26	.01	.36	.46	.06	.00
	.14	.01	.0	.24	-.06	.28	.17	-.10	-.18
GNE deflator (%)									
Year 1									
3	-.02	.01	.1	.02	.27	-.05	-.05	.12	.14
5	.09	.19	.9	.47	.90	-.02	.14	.45	.36
10	.23	.36	1.7	.55	1.04	.08	.34	.86	.27
	.61	.48	2.6	.64	1.67	.35	.95	1.61	.71
Unemployment rate (% level)									
Year 1									
3	-.12	-.11	-.5	-.15	-.09	-.14	-.25	-.01	-.04
5	-.27	-.10	-.4	-.21	-.20	-.28	-.37	-.03	-.03
10	-.15	-.03	-.08	-.17	-.09	-.34	-.31	-.04	-.02
	.02	.03	.4	-.14	-.07	-.37	-.17	-.01	.01
Exchange rate (Can$/U.S.$)[3]									
Year 1									
3	-.00	-.000	-.1	.01	.005	.001	.003	.000	-.003
5	-.00	-.001	.2	.01	.011	.002	.003	.003	-.005
10	-.00	.001	.4	.01	.007	.002	.003	.006	-.001
	-.00	.004	1.3	.02	.016	.004	.005	.009	.005
Current account balance (billions of dollars)									
Year 1									
3	-.063	-.460	-2.5	-.210	-.409	-.280	-.692	.086	-.272
5	-.340	-.930	-2.2	-.081	-.701	-.490	-.929	.124	-1.242
10	-.276	-1.090	-2.3	-.069	.635	-.743	-.935	.044	-1.698
	-.033	-1.960	-1.1	.125	-2.117	-1.739	-2.250	.171	-3.148
Real multipliers									
Year 1									
3	1.04	1.09	1.1	1.44	1.05	1.67	1.98	.42[4]	.75
5	1.31	.58	.5	1.23	1.24	1.72	2.25	.14	.22
10	1.11	.34	.2	1.25	.07	1.52	1.85	-.27	.00
	.64	.06	.0	1.48	-.44	1.41	.77	-.23	-1.03

(1) Total federal government expenditures.
(2) Nominal interest rates fixed
(3) CHASE - percentage difference between shock and control
(4) These multipliers derive from a subsequent run of the SAM model; for more discussion go to Section 9, page 29 of that paper.

SHOCK 4: A REDUCTION OF 100 BASIS POINTS IN SHORT-TERM INTEREST RATES
(Percentage difference between shock and control)

	QFS	RDXF	CHASE	DRI	FOCUS[1]	TIM	CANDIDE 2.0	SAM[2]	MACE[2][3]
Real GNE (%)									
Year 1	.19	.26	.2	.09	.35	.24	.00	.35	.24
3	.46	.55	.2	.30	2.42	.41	.25	.07	.45
5	.27	.49	.3	.25	6.02	.70	.45	-.01	.43
10	.24	.59	.5	.21	7.56	.80	.25	-.14	.60
GNE deflator (%)									
Year 1	.08	.12	.1	-.07	.51	.18	.20	.62	-.12
3	.89	.97	.8	.49	5.03	-.27	.43	2.83	.16
5	1.70	2.11	1.2	.75	15.63	-.69	.48	5.77	.62
10	3.48	4.46	2.8	.44	22.72	-.98	.01	11.18	1.17
10 (growth rate)	.49	.45	.3	-.07	7.09	-.02	-.14	.81	.10
Unemployment rate (% level)									
Year 1	-.07	-.09	-.07	-.03	-.12	-.06	-.02	-.09	-.05
3	-.41	-.38	-.21	-.21	-1.34	-.15	-.01	-.07	-.12
5	-.26	-.32	-.11	-.13	-3.09	-.24	-.02	-.07	-.06
10	-.20	-.17	-.02	-.03	-3.68	-.23	.10	-.08	-.04
Exchange rate (Can$/U.S.$ - level)[4]									
Year 1	.02	.010	1.2	.01	.019	.009	.008	.000	.007
3	.04	.027	1.7	.03	.117	.008	.011	.020	.011
5	.05	.043	2.1	.03	.298	.007	.011	.043	.011
10	.07	.070	3.9	.01	.403	.002	.002	.063	.021
Current account balance (level) (billions of dollars)									
Year 1	-.396	.180	-.04	-.004	-.471	.670	.393	-1.000	.116
3	-.744	-.030	.5	.838	-2.357	1.094	1.006	-1.461	.783
5	-.108	-.110	.9	1.154	-7.552	1.673	.776	-2.159	.821
10	-.254	2.100	1.2	.810	-7.570	3.755	1.099	-3.169	.937
Money supply (M1)									
Year 1	1.58	1.02	1.4	.28	4.55		1.21	4.73	.08
3	3.50	3.29	2.6	.84	10.30		2.07	5.30	.24
5	4.20	5.40	3.7	1.02	22.91		2.11	6.43	.56
10	5.99	8.25	5.9	.95	30.65		1.07	8.34	1.42

(1) Model solution ended in 1987.
(2) The monetary aggregate is base money.
(3) The yield on 1- to 3-year government bonds was reduced 75 basis points initially but then runs down as nominal income rises.
(4) CHASE - percentage difference between shock and control.

SHOCK 5: A $5 BILLION INCREASE IN FEDERAL CURRENT NON-WAGE EXPENDITURES
(Difference between shock and control)

	QFS	REXP	CHASE	DRI	FOCUS	TIM	CANDIDE 2.0	SAM	MACE
Real GNE (%)									
Year 1	1.61	1.50		1.66	1.07	2.26	2.73	.60	1.02
3	1.80	.82		1.31	1.16	2.13	2.90	.34	.81
5	1.66	.50		1.26	.06	1.74	2.31	.05	.75
10	.87	-.01		1.18	-.34	1.33	1.08	-.31	.02
GNE deflator (%)									
Year 1	-.08	-.01		.10	1.43	-.25	-.23	.60	.60
3	.41	.74		2.35	4.57	-.06	.76	2.46	1.89
5	1.12	1.54		2.66	5.30	.55	1.80	4.57	2.17
10	3.64	2.30		3.13	8.54	2.10	5.17	7.91	5.57
Unemployment rate (% level)									
Year 1	-.58	-.55		-.77	-.44	-.69	-1.22	-.03	-.24
3	-1.12	-.55		-1.01	-.99	-1.38	-1.75	-.17	-.30
5	-.98	-.22		-.82	-.42	-1.63	-1.44	-.19	-.28
10	-.37	.18		-.70	-.33	-1.76	-.88	-.04	-.02
Exchange rate (Can$/U.S.$ - level)									
Year 1	-.01	-.001		.03	.024	.005	.012	.000	-.008
3	-.00	-.007		.05	.056	.009	.014	.016	-.010
5	-.01	.005		.06	.036	.013	.014	.034	.015
10	-.00	.022		.09	.079	.024	.027	.044	.064
Current account balance (billions of dollars)									
Year 1	-.275	-2.360		-1.028	-2.063	-1.417	-3.466	.139	-1.287
3	-1.341	-5.010		-.413	-3.640	-2.530	-4.560	.402	-5.450
5	-1.717	-6.020		-.375	-3.225	-3.904	-4.746	.276	-7.259
10	-1.290	-9.980		.586	-10.866	-9.701	-12.396	.925	-15.491
Real multipliers									
Year 1		1.13		1.45		1.65	1.95		.87
3		.69		1.25		1.70	2.19		.73
5		.47		1.30		1.48	1.84		.74
10		-.02		1.50		1.31	1.01		.02

SHOCK 6: AN INTEREST RATE REDUCTION OF 500 BASIS POINTS FOR 90-DAY COMMERCIAL PAPER
(Difference between shock and control)

	QFS	REEP	CHASE	DRI	FOCUS	TIM	CANDIDE 2.0	SAM	MACE (1)
Real GNE (%)									
Year 1	.99	1.42		.49		1.11	.00		1.19
3	2.19	3.00		1.67		2.05	1.30		2.20
5	1.55	2.97		1.43		3.82	2.37		2.07
10	1.67	3.01		1.35		3.93	1.39		2.76
GNE deflator (%)									
Year 1	.38	.55		-.31		.97	1.03		-.63
3	4.13	4.78		2.25		-1.36	2.46		.77
5	7.89	10.80		3.79		-3.41	2.73		3.06
10	15.25	25.29		2.42		-4.42	.02		6.19
Unemployment rate (% level)									
Year 1	-.33	-.45		-.14		-.30	-.11		-.27
3	-1.74	-2.02		-1.07		-.73	-.09		-.58
5	-1.48	-1.84		-.74		-1.29	-.17		-.31
10	-1.44	-.79		-.25		-1.24	.45		-.17
Exchange rate (Can$/U.S.$ - level)									
Year 1	.08	.053		.05		.050	.040		.034
3	.19	.142		.14		.044	.063		.058
5	.24	.230		.14		.039	.064		.056
10	.35	.404		.07		.017	.010		.114
Current account balance (billions of dollars)									
Year 1	-2.021	.77		.011		3.341	1.982		.524
3	-3.844	-1.03		4.667		5.105	5.445		3.683
5	-1.719	-2.83		6.204		7.144	3.976		3.803
10	-4.036	7.90		4.058		16.415	4.693		3.086

(1) The yield on 1- to 3-year government bonds was reduced 375 basis points initially but then runs down as nominal income rises.

SHOCK 7: A ONE PER CENT REDUCTION IN THE MONEY SUPPLY
(Difference between shock and control)

	QFS	RDXF	CHASE	DRI	FOCUS	TIM	CANDIDE 2.0	SAM (1)	MACE (1)
Real GNE (%)									
Year 1	-.11	-.22		-.37	-.09		.01	-.04	-.31
3	-.07	-.13		-.05	-.40		-.17	.03	-.49
5	-.07	-.06		-.20	-.34		-.33	.05	-.31
10	-.07	-.06		-.11	-.33		-.21	-.06	-.39
GNE deflator (%)									
Year 1	-.07	-.05		.21	-.12		-.21	-.12	.16
3	-.33	-.42		-1.09	-.82		-.50	-.45	-.22
5	-.47	-.58		-.56	-1.13		-.51	-.78	-.64
10	-.88	-.77		-.38	-1.04		-.07	-1.12	-.30
Unemployment rate (% level)									
Year 1	.04	.06		.05	.03		.02	.01	.07
3	.05	.17		.04	.23		.01	.01	.12
5	.12	.00		.02	.20		.04	-.02	.00
10	.16	-.00		.01	.17		-.08	.00	.04
Exchange rate (Can$/U.S.$ - level)									
Year 1	-.01	-.008		-.04	-.005		-.008	-.000	-.009
3	-.01	-.008		-.03	-.018		-.012	-.004	-.011
5	-.01	-.009		-.02	-.015		-.012	-.007	-.006
10	-.01	-.010		-.01	-.018		-.004	-.007	-.011
Current account balance (billions of dollars)									
Year 1	.218	-.140		.095	.115		-.397	.158	-.158
3	.014	.180		-1.451	.157		-1.058	.143	-.931
5	.039	-.060		-1.005	-.251		-.910	.223	-.680
10	.237	-.230		-1.517	.753		-1.098	.218	-.791
Short-term interest rate (% level) (2)									
Year 1	.50	.82		2.83	.22		.987	.04	.926
3	.28	.03		.74	-.00		.710	-.02	.323
5	.20	.11		1.10	-.06		.738	-.01	.096
10	.01	.06		1.24	-.03		.888	.00	.376

(1) High-powered money.
(2) For SAM the interest rate on government bonds is used.

SHOCK 8: A ONE PER CENT REDUCTION IN THE MONEY SUPPLY GROWTH RATE
(Difference between shock and control)

	QFS	RDXF	CHASE	DRI	FOCUS	TIM	CANDIDE 2.0	SAM (1)	MACE (1)
Real GNE (%)									
Year 1	-.07	-.10		-.16	-.09		-.02	.00	-.31
3	-.28	-.64		-.62	-.75		-.38	-.04	-1.24
5	-.44	-.53		-.81	-1.55		-1.04	-.03	-1.74
10	-.58	-.86		-1.13	-2.13		-2.01	-.03	-2.73
10 (growth rate)	.01	-.08		-.06	-.38		-.05	.00	-.38
GNE deflator (%)									
Year 1	-.03	.00		.16	-.12		-.44	-.03	.16
3	-.46	-.61		-1.34	-1.44		-1.44	-.63	-.23
5	-1.40	-1.59		-2.35	-3.81		-2.47	-2.00	-1.70
10	-4.85	-4.57		-4.62	-7.09		-3.30	-7.61	-5.40
10 (growth rate)	-1.0	-.77		-.19	-.96		.21	-1.23	-.65
Unemployment rate (% level)									
Year 1	.02	.03		.06	.03		.07	.01	.07
3	.15	.40		.58	.40		.14	.03	.33
5	.46	.33		.53	.88		.22	.02	.40
10	.79	.35		.64	.98		-.09	.06	.22
Exchange rate (Can$/U.S.$ - level)									
Year 1	-.01	-.004		-.02	-.005		-.016	-.001	-.009
3	-.03	-.023		-.08	-.036		-.041	-.004	-.032
5	-.05	-.036		-.12	-.070		-.064	-.013	-.046
10	-.11	-.076		-.20	-.109		-.081	-.040	-.097
Current account balance (billions of dollars)									
Year 1	.135	-.08		.083	.116		-.544	-.050	-.158
3	.443	.15		-2.343	.558		-2.652	.277	-1.757
5	.601	.17		-3.930	.672		-4.714	.754	-3.165
10	1.248	-2.96		-13.462	.429		-12.011	2.153	-5.250
Short-term interest rate (% level) (2)									
Year 1	.39	.48		1.80	.22		.960	-.41	.926
3	.91	.93		2.98	.31		2.179	-.61	1.640
5	1.24	1.05		5.56	.11		3.609	-.73	1.735
10	1.67	1.56		12.59	.51		7.825	-.93	2.512

(1) High-powered money.
(2) For SAM the interest rate on government bonds is used.

SHOCK 9A: A DEPRECIATION OF 10 PER CENT IN THE EXCHANGE RATE WITH MONETARY ACCOMMODATION
(Shock minus control as a percentage of control)

	OFS	RDXF	CHASE	DRI	FOCUS	TIM	CANDIDE 2.0	SAM	MACE
Real GNE (%)									
Year 1	1.33			.83	3.05		.20	1.14	.26
3	.95			.58	2.28		1.54	.69	1.26
5	.18			.71	2.21		2.39	-.03	1.65
10	.05			.55	1.22		1.41	.72	1.75
GNE deflator (%)									
Year 1	.72			-.32	5.35		2.77	2.69	2.21
3	3.60			2.70	8.09		4.44	7.33	5.90
5	4.38			2.91	8.80		4.68	11.15	9.96
10	6.35			2.68	9.48		3.94	7.41	9.53
Consumer price index									
Year 1	1.83			1.11	5.59		3.31	3.36	2.87(1)
3	3.72			3.08	7.32		4.42	9.02	5.81
5	4.16			3.17	7.62		4.43	12.91	9.16
10	5.87			2.94	8.04		3.20	8.28	8.86
Unemployment rate (% level)									
Year 1	-.54			-.40	-1.42		-.48	-.12	-.25
3	-1.15			-.57	-1.34		-.41	-.45	-.50
5	-.25			-.36	-.98		-.46	-.23	-.17
10	-.09			-.23	-.38		.07	.25	.05
Current account balance (level) (billions of dollars)									
Year 1	-2.884			.004	-3.523		3.420	-1.340	.794
3	-1.214			4.583	.015		6.788	-2.320	4.974
5	.881			5.319	.722		6.112	-4.130	2.467
10	.370			8.701	-.796		14.378	-6.990	-4.421
Short-term interest rate (% level)									
Year 1	-5.75			-8.94	-6.68		-5.77	-.63(2)	-.82(3)
3	-2.17			-5.25	-3.74		-4.10	.08	-1.02
5	-1.50			-5.85	-3.59		-4.52	.29	-.81
10	-.50			-9.87	.39		-5.19	-.24	-.20
Money supply (M1)									
Year 1	11.59			5.00	39.19		6.60	10.00(4)	3.18(4)
3	10.36			3.88	24.86		7.51	10.00	8.04
5	8.35			4.47	24.65		6.09	10.00	12.12
10	7.79			11.72	8.10		-1.54	10.00	11.02

(1) Absorption price. (2) The yield on government bonds. (3) The yield on 1- to 3-year government bonds. (4) Base money.

SHOCK 9B: A DEPRECIATION OF 10 PER CENT IN THE EXCHANGE RATE VIA AUTONOMOUS FORCES
(Shock minus control as a percentage of control)

	QPS	RDXF	CHASE	DRI	FOCUS	TIM	CANDIDE 2.0	SAM	MACE
Real GNE (%)									
Year 1	.30	.66		.72		.95	.33	.69	-.71
3	.04	.07		.73		.92	.88	.39	-2.67
5	-.52	.07		.65		1.03	.80	-.32	-4.69
10	-.78	.38		.70		1.53	.50	-.93	-5.01
GNE deflator (%)									
Year 1	.62	.81		-.16		3.06	2.93	1.84	2.70
3	3.20	3.04		3.08		4.52	4.03	4.84	7.33
5	4.50	4.97		3.21		5.37	4.32	7.59	11.01
10	7.28	8.52		3.42		5.57	.74	8.97	10.39
Consumer price index									
Year 1	1.89	1.34		1.46		3.49	3.62	2.17	3.00(1)
3	3.76	3.37		3.28		4.85	4.27	5.77	6.55
5	4.93	5.45		3.45		5.55	4.32	8.50	9.49
10	7.64	8.82		3.48		5.64	-0.08	8.53	9.36
Unemployment rate (% level)									
Year 1	-.18	-.29		-.39		-.47	-.65	-.03	-.05
3	-.49	-.22		-.65		-.67	-.67	-.38	.37
5	.04	-.12		-.31		-.68	-.52	-.29	1.15
10	.24	-.27		-.29		-.99	.44	.21	.23
Exchange rate (Can$/US$ - level)									
Year 1	.11	.108		.12		.108	.099	.121	.092
3	.10	.095		.12		.109	.083	.116	.074
5	.10	.123		.12		.108	.076	.103	.071
10	.10	.139		.12		.106	.014	.073	.118
Current account balance (billions of dollars)									
Year 1	-2.092	2.110		.422		3.084	2.086	0.64	.199
3	1.085	3.530		4.495		2.985	3.688	1.61	.094
5	2.287	3.960		5.760		2.876	4.114	1.82	-6.346
10	1.884	0.040		10.142		5.219	3.335	2.94	-24.923
Short-term interest rate (% level)									
Year 1	.61	.86		.01		.35	-.26	.25(2)	2.07(3)
3	1.56	2.04		.08		.07	1.79	.91	4.64
5	1.86	2.28		.01		-.00	.40	1.09	6.15
10	2.93	3.56		.00		.00	-5.02	.50	5.70

(1) Absorption price. (2) The yield on government bonds. (3) The yield on 1- to 3-year government bonds.

FIRST DISCUSSION SESSION: A REVIEW OF MODEL RESPONSES

Chairman, Bill White

Bill White opened the session by suggesting to participants that an issue by issue approach, using individual shocks only to elaborate on the topics under discussion, might be more productive than a shock by shock approach. In addition to the issues identified by J.-P. Aubry and Dennis Featherstone in their opening remarks, which essentially had to do with structural specification, Bill White indicated that he would like subsequently to pursue issues having to do with methodology. After a short introduction outlining the standard theoretical view of the dynamic response of output and prices to monetary policy and contrasting it with the simulation results, Bill posed the first issue: Should models incorporate such concepts as a non-accelerationist long-run unemployment rate, purchasing power parity, and the long-run neutrality of money?

Incorporating Long-Run Properties

John Helliwell, Bill White, and J.-P. Aubry began by pointing out the particular simulation results that were relevant to this issue. Bill White noted that, with the exception of CANDIDE, most models were not far away from reflecting monetary neutrality over a ten-year period. Ross Preston suggested that the real question should be how to test for money neutrality since, if it is imposed but is not true, biases will be introduced into the policymaking process. He also commented that a fully formulated money supply shock in the Canadian context requires explicit identification of the behaviour of the American monetary authorities. J.-P. Aubry asked what mechanics in CANDIDE would explain the increase in the growth rate of the GNE deflator by the tenth year in response to a reduction in the money supply growth rate. Someshwar Rao replied that the CANDIDE response was the result of the exchange rate movement, which was

in turn caused by the activity effect (long-term capital flows) eventually dominating the substitution effect (Canada-U.S. interest rate differentials). J.-P. Aubry wanted to know on what basis this dynamic behaviour was allowed to stand. Ross Preston stated that he was not defending the CANDIDE results as being better than those of other models, but he reiterated that he did not think any property should be forced on a model.

Bill White sought the views of other modellers on the question of imposing longer-run properties. Jack Selody thought the question should be re-posed to ask why homogeneity is not obtained, explaining deviations from the hypothesis rather than accepting whatever the data indicated in the first instance. John Helliwell believed it would be helpful to distinguish between the properties one would want to impose at the equation level and the properties desirable at the whole model level. He stated his belief, however, that imposed restrictions should be tested at all model development stages and the results reported. Bill White queried Jack Selody and David Rose on their experience with SAM in the context of John Helliwell's remarks. David Rose stressed that the approach taken depended on the nature of the problem, with some things being fundamentally untestable and leaving you with no choice but to operate on the basis of priors. He then described the experience with the curvature of the wage equation in SAM before stating that neutrality is not imposed in SAM. David Rose did note that he would be disappointed if growth rates in the model did not settle down in the steady state to a neutrality-type result but in terms of levels this probably would not occur. J.-P. Aubry returned to the question of testing restrictions, citing his life cycle experiments as one indication of the difficulty of tracing micro-linkages at the aggregate level. He suggested that the recent variance in financial data might help in identifying real-financial linkages at some point in the future. However, given the existing data requirements necessary to test for long-run monetary neutrality one should not hesitate to impose

it, even if empirical evidence is not robust, if one believes that is how the world works. Bill White cited, as an example of a result at variance with what might be expected a priori, the widening (through the tenth year) of the gap between shock and control in real GNE in the money supply growth rate shock for the RDXF, MACE, FOCUS and CANDIDE models. He then asked what properties should be imposed to obtain reasonable long-run results, particularly given that these models are increasingly used for medium-term simulations. John Helliwell cautioned that the longer-run constraints that people would normally think of applying are more relevant to a situation with fixed real interest rates. The large variance in real interest rates in the last several years may cause some models to lose such desired properties as homogeneity. J.-P. Aubry and Peter Dungan discussed why the 500-basis-point interest rate shock had a convergence problem in FOCUS, whereas the money supply growth rate with approximately the same magnitude of interest rate change but of opposite sign did not. Several ways of investigating this issue were proposed and possible reasons for the difference were advanced. David Rose added that if one tried to change interest rates in SAM solely through changes in the money supply he would expect to get the same type of explosive result as in FOCUS.

David Rose suggested that there is no right answer as to what constraints should be imposed on models and that no one model can do everything we want. He indicated that the tradeoffs in model building may be such that it is not worthwhile to impose long-run properties on models used for short-term forecasting and analysis. Leo de Bever stated that, in practice, forecasting models will almost inevitably be used for carrying out simulation exercises as well, requiring that models have credible underlying dynamic properties. This, together with the fact that most problems with model forecasts can be traced to the misapplication of economic theory, implies that attention must always be paid to proper structural specification. Ross Preston indicated that

unless one accounts properly for the path to an imposed equilibrium, empirical results are likely to be biased. He suggested that the reason why modellers fail to justify their priors is because of poor data, and imposing priors might be considered as calibrating for specific results. Bill Empey said that he would have no hesitation in imposing priors where it was clear how to do it but that he was not sure how one would impose neutrality even if one wanted to. David Rose concluded the discussion on this issue by reiterating that there is a big difference between priors representable as parameter restrictions and such consistency requirements as identities and stock/flow relationships.

Identifying Expectations

At this point Bill White proposed that modellers move onto the issue of expectations. Jack Selody described the response of SAM in a simulation of a standard depreciation with monetary accommodation in which autoregressive expectations formed on the basis of five-year lags gave the counter-intuitive short-run result of rising interest rates. Ross Preston queried whether modellers should concern themselves with modelling expectations processes as opposed to just learning how to handle time in their models. Bill White emphasized the need to distinguish expectations from those broad dynamic processes that may be generated by other forces (say, stock adjustment) and asked Peter Dungan about the experience in FOCUS. Peter Dungan said that expectations processes are stressed in the formation of real wages and real interest rates in FOCUS. The method used is called synthetic expectations and essentially entails deriving the best equation for making inflation forecasts and throwing away the errors. Bill White pointed out that this approach assumes all people form expectations in the same way and asked if it made sense. Peter Dungan replied that except for interest rates it probably did not make sense. There was a brief exchange between Tim Padmore, Someshwar Rao, Mike McCracken and Ross

Preston on how people form expectations in practice. Bill White asked whether people should properly be considered to base their expectations on what is happening currently (or has recently happened) or on a forward-looking basis given some model they keep in their heads. John Helliwell noted that even in the case where you have expectations-type data (for example, investment intentions) there is an advantage to formulating a specific model to aid in identification of decision lags and expectational errors. Bill White reminded John of his earlier remarks to the effect that short-run deviations from the production function depended upon unexpected changes in profits and/or demand, and asked how this emphasis on expectations is implemented. John Helliwell described how MACE dealt with embodied expected sales, desired factor demands, and adjustment processes based on deviations between actual and desired sales and factor demands, but noted that expected future sales are not themselves a realization of the model run. Pat Grady thought the real weakness with identifying expectation processes was the lack of data and suggested that more use could be made of surveys with the resulting information, poor as it may be, providing an additional cross-check on priors. Ross Preston returned to his earlier point by asking if anybody was doing Monte Carlo stochastic type work on expectations processes and analyzing the resulting generated data. J.-P. Aubry mentioned his life cycle work and its weaker explanatory power relative to a current income model. This led Ross Preston to conclude that the world is characterized by "garden variety" time-dependent processes that make it difficult to identify structural elements. J.-P. Aubry expressed concern about identifying the horizon of expectations and about the existence of institutional factors leading to the observation of time-dependent processes that might be mistakenly identified as the effect of expectations.

Modelling Real-Financial Linkages

With respect to the issue of real-financial linkages, Bill

White proposed dividing the discussion between the short-run impacts of monetary policy on the real side, where he suggested empirical models might underestimate such effects, and the impact on prices. Of particular interest with respect to the latter is the extent to which the positive (negative) effects on prices of greater excess demand (supply) resulting from interest rate reductions (increases) might be offset by such things as unit capital costs. John Helliwell pointed out that the average of the models seemed to indicate that a 500 or 600 basis point increase in interest rates would cause real GNE to decline by about 3 per cent and wondered how much larger the effect should be. Bill White said that it appeared that these results came largely through exchange rate effects and wondered what the models would show if this link were eliminated. John Helliwell used MACE to compare the effects on real GNE of an exchange rate depreciation with monetary accommodation and a similar shock with the money supply constant; the difference was suggestive of sizeable domestic real-financial linkages. Krishna Sahay felt that the QFS model also has important domestic linkages, particularly in the inventory and housing sectors. An additional channel in MACE noted by John Helliwell is through movements in real balances and the resultant wealth effects in the consumption sector. Mike McCracken observed that there were two major channels in TIM: on the real side large effects of lower interest rates came through the investment equations, and on the price side there was the exchange rate effect. He indicated that further work had to be carried out on corporate cash flows, particularly in the context of understanding what drives international capital flows. Leo de Bever remarked that one real-financial linkage that had always disappointed him in empirical work was that of interest rates on inventories, and he wondered how it was achieved in MACE. John Helliwell said that it was not large in MACE and that it entered implicitly since the optimal inventory is modelled as a fraction of the capital stock in order to have consistency, with inventories being treated as a

factor of production. Heather Robertson indicated that in QFS investment is modelled as an adjustment to the desired stock and that a term representing the expected real holding cost of inventories was quite robust. David Rose outlined two channels in SAM for real-financial linkages: real interest rate movements affect steady state sales and labour supply decisions, which are based on life-cycle models, and the direct real rate effect on the capital stocks was significant in estimation but weak. Mike McCracken said that the direct real interest rate effect in TIM was concentrated in the durables and non-durables inventory equations. He noted that, in a lower interest rate simulation, inventories will increase eventually because of a higher level of economic activity.

J.-P. Aubry asked for some feedback on whether interest income was endogenous in most models; to the extent that it is, higher interest rates may raise consumption rather than lower it. He also alluded to the data problems that have arisen recently with respect to income. Mike McCracken discussed the experience with TIM; stating that most modellers could be expected to begin by defining government interest endogenously. He mentioned some of the simulation problems that can arise if private interest components are not modelled adequately and outlined some useful cross checks (looking at investment-saving breakdowns and income flows from the rest of the world). Leo de Bever said that CHASE has all components on the income side endogenized with the result that downward income effects from interest rate reductions are very significant because of the size of the government debt; this partially explained why their multiplier in that shock was not as large as might have been expected. Leo also raised the point that a significant portion of interest payments must be used to prevent erosion of real wealth through capital losses and should not really be viewed as income from a consumption theory point of view. David Rose again referred to the perhaps too strong link to the real side in SAM derived from the life cycle formulation of the consumption and

labour supply decisions. Real rate movements are associated with the rate at which people discount future income flows, and this has a strong effect on current consumption decisions. Moreover, interest rates on the government debt are endogenous in SAM, resulting in some interesting implications for taxes, the residual financing item, in simulation. David also expressed concern that one of the biggest weaknesses in existing models stems from the lack of attention to balance sheet constraints, particularly given developments in the current economic cycle. John Helliwell said that in MACE the consumption function runs off wage income and the market value of wealth, the latter effect being not inconsequential. Bill White asked whether anybody was planning any other initiatives on modelling real-financial linkages. Bill Empey mentioned a non-linear effect of interest rate changes on the ability to pay mortgages that DRI had incorporated in their housing sector and the inclusion of a cash flow term into the business non-residential investment equations.

Linking Prices and Monetary Policy

Bill White proposed turning to the question of prices and monetary policy, noting that most of the models except TIM show a decline in prices relative to control given a tighter monetary policy. Jack Selody remarked that in SAM capital costs go directly into prices with the long-run effect constrained by the requirement that the price level balance supply and demand. He further noted that it was surprising how quickly a money shock translated in the standard way into prices. John Helliwell pointed out that the degree and method of normalizing the productivity effect, something for which the data are not much help, are important elements in determining the result obtained. Mike McCracken mentioned that the high degree of regulation in the economy was captured by TIM's sectoral disaggregation and was part of the reason for the difference between TIM's results and those from the other models. Mike said that this was perhaps overstated to some extent, since TIM does not have a strong

exchange rate response. Peter Dungan commented on the experience with FOCUS when the exchange rate is exogenized. An increase in the money supply lowers the price level because capital accumulation is effectively financed out of Bank of Canada exchange reserves, and the supply curve is moved outward. He said that the FOCUS experience with mark-up equations to incorporate an interest rate effect had not been very successful and he wondered how much of the effect in TIM arose from the regulated sectors. Mike McCracken responded that the positive effects on prices of higher capital costs were indeed most obvious in the regulated sectors, but occurred in some other sectors of manufacturing as well.

Crowding Out

Bill White raised the issue of crowding out, referring to the tendency of the real expenditure multipliers to fall over time in the simulations presented. He referred as well to the apparent change of view among policymakers and theorists (i.e., the rational expectations school) about the size of the multiplier and the importance of government deficits. John Helliwell commented on the relative shift towards surplus by provincial governments, which are used to borrowing abroad, and towards deficit by the federal government, which is not; the implication of this is that inexperienced private companies either have to go abroad for financing or face being crowded out on domestic markets. He emphasized that the assumption made as to how the deficit is financed makes a large difference to the fiscal multiplier in MACE. David Rose interjected that the financing rule was also important in SAM but only for the first few years, after which the multipliers in all cases will come down. J.-P. Aubry asked whether a government growth shock as opposed to a one-year spending increase would make a difference to the length of time that SAM would show a gain. David Rose replied that the answer to this question for SAM depended on what rules were imposed on the tax system given the

approach taken for consumption and labour supply and the progressivity of the tax system. The decision on how to set marginal and average tax rates in order to finance increases in government expenditures has an important effect in SAM. He ventured that there would only be a small labour supply reaction because taxes would likely go up and the returns from work would go down. J.-P. Aubry and David Rose discussed this labour supply response further, citing recent statements emanating from the U.S. Congress and the Canadian experience of the 1970s.

Handling Supply Side Shocks

Bill White steered the meeting toward the supply side issues outlined by J.-P. Aubry in his introductory remarks. He wondered whether modellers wanted to follow the example of models like MACE and SAM which, having endogenized such things as productivity growth, are able to have a relatively greater ability to handle supply side shocks. John Helliwell volunteered that monetary and fiscal policy are not affected by treating energy separately, but that if energy prices change it matters greatly to the results. J.-P. Aubry asked what potential output is in the MACE model given John Helliwell's earlier assertion that MACE can explain the 1970s' drop in productivity. John Helliwell replied that MACE's technology is Harrod-neutral and that potential output hinges to a large extent on what is happening to energy prices and the terms of trade.
Mike McCracken concurred with the need to look at energy separately. The government-imposed pricing structure to 1986 will create different income flows and distribution of rents than would a market situation, and it is important to identify the implications of possible supply response scenarios. John Helliwell added that large changes were now occurring in the use of different fuels and if the energy sector is not treated separately there would be some significant problems with forecasting, particularly with respect to the balance of trade. Bill White asked if this modelling should be extended further,

for example into the raw materials side. John Helliwell felt this would not be necessary; the fact that other resource products are so diverse and that resource rents in the oil and gas sector account for 98 per cent of all resource rents imply that raw materials could just be treated as value-added. David Rose agreed that the presence of an energy sector in a model provided more flexibility but cautioned that one should not lose sight of an important element of the supply side that has nothing to do with disaggregation--the consistency between the factor demands and the technology in the long run. He remarked upon a flaw in SAM: energy output is exogenous, with the result that energy in excess of the requirements of the non-energy sector is exported, resulting in curious trade balance effects.

Bill White directed modellers to the issue of how imbalances between demand and supply are resolved. He reminded participants that in a number of models "short-run" productivity was still making an important contribution to output ten years after an initial demand shock. John Helliwell indicated two ways to get rid of perennial short-run productivity, and noted that ideally both should be included. The first approach acts through the factor demand equations to ensure consistency with the production side and the second approach puts more reliance on excess demand terms in the price and trade sectors. J.-P. Aubry sought comments from the modellers of CANDIDE and TIM, where supply modellers of CANDIDE and TIM, where supply was highly disaggregated, on the ways in which supply and demand over the longer run responded to changes in demand. Ross Preston replied that in CANDIDE sector prices depended on unit labour and capital costs, production and the wage rate. J.-P. Aubry queried whether links existed between what is usually produced and what the production function would produce. Ross Preston said that CANDIDE had some generally stipulated results but questioned how far one could go outside of the manufacturing sector. J.-P. Aubry noted that in modelling RDX2, effort had been put into having some sort of disequilibrium between demand and supply

going directly into prices but that it had been very difficult to obtain useful results. He thought that the impact of differences between markets might have been more evident at a greater level of disaggregation. Bill White asked about DRI's experience in this area. Bill Empey said that DRI does not have disaggregated utilization rates by industry but it does have unit cost variables built up through the input/output tables. In addition to relative unit labour cost terms, industry specific terms are incorporated into the detailed output price equations. J.-P. Aubry, Mike McCracken and John Helliwell discussed how, in the TIM model specification, bottleneck effects might be captured. The conclusion was that the way it happened really depended on the sector one wanted to focus on.

SECOND DISCUSSION SESSION: WHERE DO WE GO FROM HERE?

Chairman, Pat Grady

The session was opened with remarks from its chairman, Pat Grady, in which he listed the uses to which models currently available are commonly put. He felt that modellers should be asking themselves whether the current structure of models is adequate for producing useful policy advice on the key economic issues of today. In particular, he pointed to the divergent results obtained from the models with regard to the long-run impact of fiscal policy, as well as to some disagreement on the effect of monetary policy on inflation. After reviewing the useful achievements of the previous two comparative models conferences, Pat raised the issue of the role of capacity utilization variables in the models. He asked the modellers whether their models generated non-linearities in response to shocks of varying magnitude.

Mike McCracken and Peter Dungan suggested that one reason there is little evidence of non-linear responses in the simulations presented is the low level of capacity utilization present in the control solutions. In TIM, even a $5 billion tax cut does not bring the economy close to full capacity utilization. Peter Dungan indicated that one method to circumvent this problem is to recalculate the data so that the base case becomes one where the economy is at high capacity (in essence, "fooling" the model into thinking high levels of utilization exist). In an experiment in which the FOCUS model was tuned to put unemployment at 2% below the natural unemployment rate, the response to a positive demand shock did indeed prove to be much smaller on the real side and much greater with respect to prices. Pat Grady and Bill White raised the issue of the effects of changes in the exchange rate at different levels of capacity; a depreciation at full employment would be expected to have a greater effect on inflation than when a great

deal of slack existed in the economy. It was noted that this question has significant implications for policy, given the important role that stabilizing the exchange rate plays in the setting of monetary policy. Bill White questioned whether this issue could be adequately resolved given the limitations of the data.

Noting that some important methodological issues had not yet been covered in the day's discussion, Pat Grady pointed to the large differences that currently exist between models. The models have been developed by different groups for different purposes, for use over different time horizons, with varying amounts of emphasis on sectoral disaggregation and the supply side. Whereas Leo de Bever had stated earlier that he did not want to sacrifice theoretical rigour in the development of a forecasting model, and Ross Preston had concurred that it is not inconsistent to use a structural model for forecasting purposes, Pat questioned whether it is appropriate to employ a model which had been specifically designed with short-term forecasting in mind for policy analysis and longer term projections. Pat further asked for comments regarding the specification of criteria for choosing between models, and whether all models are sufficiently good for their own particular purposes.

John Helliwell noted that he was uneasy with the suggestion that there is a trade-off between forecasting ability and model structure. He felt a soundly based theoretical model would not only be easier to use and give more satisfactory results, but would be more comprehensible with respect to its dynamic properties and responses to shocks. After asking the modellers to participate in a series of energy price shocks, which he was carrying out in another context, John also suggested that further shocks were required in order to better understand the effects of alternative financing methods on the size of fiscal multipliers. In particular, it would be helpful to have fiscal shocks, assuming alternatively that nominal interest rates and M1 were fixed. With respect to the question of requiring different

models for different purposes, Jack Selody responded that the answer had to be yes. Given the complexity present in the real world, modellers must necessarily specialize. The principal question to be asked is what elements are required for a model with a specific purpose.

Bill Empey indicated that in order to generate the non-linearities discussed earlier he was tempted to carry out further sectoral disaggregation. However, a serious effort to model output prices and capacity utilization by sector would imply significantly larger models. He was concerned with the trade-off between obtaining these sectorally specific non-linearities (and bottlenecks) suggested by the supply side, and the amount of resources required to forecast using a larger model. He also expressed concern that this may lead to a de-emphasis on macroeconomics, with the eventual result a general equilibrium model. John Helliwell also cautioned against going too far down the disaggregation route. He did not feel that more industrial disaggregation was necessary in order to obtain either a usable model or evidence of non-linear restraints. Moreover, a model with a coherent theoretical structure as well as matched supply and demand was easier to obtain with less disaggregation than with more. Thus MACE tends to be smaller and more aggregated in terms of both time and number of equations than earlier models. Peter Dungan pointed out that the Conference Board was working on a limited disaggregation model that does seem capable of producing sectoral bottlenecks; thus the level of disaggregation required may not be as large as many of the discussants were implying. Bill White stressed the importance of making the distinction between tradeable and non-tradeable goods. Levels of capacity utilization may vary significantly between the two with implications for the expansion of demand. Going in the direction of further disaggregation, however, may add to complexity to the point of becoming impractical.

In response to a question from Pat Grady, Bill Empey said that he did not feel there was a trade-off between a model used

for forecasting and one used for simulation experiments. If, after building the best theoretical model possible, it fails to capture actual economic developments, then you should compensate with the explicit use of judgement. He then described recent experience with a cash-flow term in the investment equation of the DRI model, which helped considerably to explain recent history. J.-P. Aubry pointed out that the distinction between forecasting and policy analysis is not as large as may be thought. As you proceed from one forecast to the next you are putting your model through a set of shocks as new information is introduced. If the model cannot handle shocks of the type used in simulation experiments, he suggested, it is difficult to see how it can forecast adequately.

David Rose asked whether, in principle, currently available models can be expected to do what we are asking them to do. Although not necessarily agreeing with it, he pointed to the growing literature on Lucas-type criticisms of simulation practices, as well as to the argument (put forward by Sims and others) that structural models add little, if anything, to our knowledge of how the economy works. Critics of current structural models suggest either a new type of behavioural model, or the abandonment of structural models in favour of large reduced-form models. In light of the earlier discussion on expectations, David noted Lucas' point that the way in which expectations are formed is crucial to the way policy shocks are introduced into the model. David asked for other modellers' views, suggesting that there were some things that could be done in simulations of structural models to reduce the impact of these criticisms.

Leo de Bever felt that, in terms of providing reasonable information on which to base practical decisions, there was currently little alternative to available structural models. While better models are surely preferable, the radically different models suggested by some are of little help until they are available in a usable form. Even then, these newer models

may be subject to criticisms themselves. J.-P. Aubry felt that not only does the possibility exist that a large reduced-form model would prove to be unstable, but that it would be difficult to provide adequate explanations of the dynamic responses to shocks implied by such a model. He also noted that current structural models are not static but may be continually modified, thus providing a great deal of flexibility. David Rose expressed the concern that simply responding to historical changes and circumstances alone is inadequate for simulation exercises. J.-P. Aubry stated that if the past structure was no longer valid you can impose the equation coefficients that correspond to your judgement. Mike McCracken suggested that an alternative way of looking at a model is to think of it as an information collection device. As you build up a forecast you are obtaining information about what is happening to the economy and the structural changes taking place within it. In addition Mike suggested that there was a difference between forecasting and policy simulations. The simulation rules required for each exercise might well be different, particularly if the time horizon being dealt with was the longer term.

Pat Grady summarized the preceding points, observing that the discussion had revolved around theory and theoretical points. He pointed to some important data issues that had not been dealt with; in particular the appropriateness of the national accounts in a situation of inflation. Pat reiterated the comment made by several participants that the high real interest rates of today introduce a lot of variability in the data that will eventually show up in the structure of the models. Of particular interest, however, was the virtual absence of any discussion of econometric techniques; there appeared to be a consensus among model-builders that they are of second-order consideration.

APPENDIX A

INTRODUCTORY REMARKS

ISSUES FOR THE COMPARATIVE MODEL SEMINAR

Jean-Pierre Aubry
Bank of Canada

Before asking the model builders to describe their models, I would like to suggest a number of issues around which we might structure our discussion.

The development of economic theories in the last 15 years has raised many questions for the builders of large macro models that are based on the so-called "Keynesian" approach. More and more economists talk about the natural rate of unemployment, about the neutrality of money and about a direct link between monetary aggregates and prices. On the other hand, the energy crisis has also raised many questions on the existence of supply constraints, on the quality of our two-factor production functions, on the evolution of productivity and on the importance of the link between prices and the supply-demand imbalance.

Models have been accused of being mainly demand determined and of explaining the inflationary process too poorly. In most of them, inflation has been exogenously determined with foreign inflation as its main source. Economists have also criticized the models for overestimating the effect of fiscal policy on output, for having little to say about relative price shocks and for having overly long adjustment lags. To that list one can add the doubts cast by the literature on rational expectations, which seriously calls into question the ability of existing models to analyze any policy shock.

Faced with all of these attacks, builders of large econometric models were thrown off balance. They realized that their understanding of the dynamics of their own models was incomplete; the myth of the large econometric model as the perfect tool for policy analysis had faded. Model builders were forced to go back to the drawing board.

Expected and Realized Dynamics

Model builders realized very quickly that there was a large gap between what they had planned and what they had effectively built. Too often models were built sector by sector, and some big surprises occurred when a model was finally run as a unit. The larger the size of the model, the bigger was the surprise. Anyone reading the documentation of the first versions of RDX2, TRACE and CANDIDE will see that the builders of those models had a clear vision of a macroeconomic demand interacting with a macroeconomic supply. They planned to estimate one or many production functions, and they planned to have a demand for factors that was coherent with the production function. They planned to introduce the disequilibrium between supply and demand in the price and in the wage equations. After the estimation stage, however, model dynamics were quite different. For example, it proved very difficult to introduce supply-demand disequilibrium into the price equations and even more difficult to discriminate between a linear and a non-linear function.

The case of modelling price determination is a very good example where many were lost meandering in the field of disaggregation. A year ago, I was in Paris participating in an OECD meeting where economists were presenting a set of national models. At the beginning of the meeting the chairman asked this question:

> Looking at the specification of your price and wage equations, it is evident that wages explain prices and that prices explain wages, but can you tell us what are the true determinants of prices in your models?

I should say that in the following two days no model builder answered this basic question. And, maybe, it would be hard for many of us to give a clear answer to that question today.

I know that I could not have given a good answer when the construction of the last version of the Bank of Canada's model RDX2 was completed. It was only when we completed the study on

the dynamics of the price, wage and exchange rate sectors that we began to understand the dynamics of the price formation in RDX2. Charles Freedman's technical report entitled "Models of Inflation: A Taxonomy of Effects" gives a very useful framework for addressing that question. Even today, when I read the Eckstein book on core inflation, I am tempted to conclude that the price formation process in large macro models has not yet been completely understood.

The Accelerationist Model and the Price, Wage, Exchange Rate Bloc

Many macro economists want their models to have one particular property of the accelerationist model, namely, a temporary period with actual unemployment above the natural rate of unemployment that is sufficient to reduce the rate of inflation permanently.

Many constraints are needed to obtain such a dynamic response. The price level has to be a homogeneous function of degree one with respect to the sum of all costs; each cost has also to be a homogeneous function of degree one with respect to other costs or other prices; and the exchange rate has to be a homogeneous function of degree one with respect to domestic prices or costs. Thus, the simple decision of exogenizing the price of energy or the price of food or the price of the Canadian currency has the effect of putting the model properties further away from those of an accelerationist model. It has to be acknowledged that many prices in Canada are set outside free market rules, which is a good reason to exogenize them, at least for a few years. One should also note that the length of adjustment lags, especially in the exchange market and in the labour market, can also mask desired properties. Given such assumptions the models may imply that inflation will be for a time outside the close control of monetary authorities. Indeed, some such assumptions may even imply there is a long-run trade-off between the inflation rate and the unemployment rate.

In such a model, an increase in the unemployment rate reduces the rate of inflation, but any return to the previous rate of unemployment results in an increase of inflation. In such a model, the power of fiscal policy is amplified and the power of monetary policy is reduced. This was the case in RDX2 where the price equations were not homogeneous with respect to factor costs, and in consequence the long-run Phillips curve was not vertical.

These homogeneity conditions in the price, wage, exchange rate bloc are crucial in the determination of model properties. I hope that model builders will tell us if such conditions hold in their models; specific reasons for their absence would also be appreciated.

Monetary Policy Channels
And Rational Expectations

Before talking about issues on the supply side, I want to briefly discuss the modelling of monetary policy channels and of expectations. First, given the small variance of real ex ante interest rates observed in the sixties and seventies, one should not be surprised that it has been difficult to model monetary policy channels. Most model builders cannot find empirically strong and stable monetary links, either at the consumer level or at the level of the firm. Even in markets where it should be easier -- for example, the exchange rate market -- it is a difficult task to estimate precisely the effects of interest rate or monetary aggregate fluctuations. What channels we do have in our models have been to a large extent imposed, and this fact should be kept in mind when we interpret the responses to the monetary shocks.

In my opinion, the most underestimated channel of monetary policy is that of "cash flow". The simulation results from the corporate tax shock may help on this point. On the other hand, one of the channels of monetary policy whose influence may have been overestimated by modellers has to do with the formulation of

expectations. With the increased emphasis in the literature on the importance of rational expectations, expectations terms based on monetary aggregates instead of on autoregressive expectations have frequently been entered directly into consumption, wage, price and exchange rate equations. And with this type of specification, there is a risk of having the following type of causality:

> The monetary aggregates have an impact on prices because the economic agents expect that they will have one.

This is what I would call a self-fulfulling expectation. I think the use of this type of expectation in a model can be justified only if it is consistent with the dynamics of the model. An easy way of testing such a coherence is to simulate a monetary shock in a model using only adaptive expectations, and to verify whether the long-run properties are similar to those of a model that bases expectations on projections about the growth of monetary aggregates. If both models have the same long-term response, it is then appropriate to use expectations constructed directly on monetary aggregates in order to increase the speed of adjustment. I hope that the model builders will tell us if they are using this type of expectation in their model and how it affects model properties.

Many economists might be tempted to judge the quality of a model's response to a money supply shock solely on the basis of whether the homogeneity condition between prices and monetary aggregates is met. This criterion ignores the fact that it is also very important to see if output and the unemployment rate are back to their control solutions. I invite model builders, when they comment on monetary shocks, to discuss not only the price response but also the output response.

Supply

As I mentioned before, the relative price shocks to the world economy in the last ten years have raised many questions

about modelling the supply side of the economy. At the same time, concern has been growing because of the inability of demand-oriented policy initiatives to maintain the economy at traditional levels of "full employment" without seeming to generate inflationary pressures. More and more model builders have replaced their traditional two-factor production functions by more sophisticated ones that include energy and raw materials as input. I would like to know if these changes have had an effect on model responses to standard monetary and fiscal shocks.

Another aspect of the modelling of the supply side has to do with the response of output to expansionary demand shocks. Very frequently one sees models that, in the short run, validate a large increase in demand by large increases in productivity. This in turn generates price reductions rather than the increases that might normally be expected, particularly if there are sectoral bottlenecks or the economy is operating near full capacity. Still more seriously, one often sees models that, in the long run, validate large increases in demand by permanent increases in short-term productivity. Should we not expect from models that have an extensive disaggregation of the supply side a better adjustment mechanism to demand-side shocks? On that subject, the analysis of our model responses to similar shocks of different amplitudes will also be quite revealing.

Reduced Form Models: A Good Standard for Comparison?

I would like to raise briefly the issue of using highly reduced form models to judge the dynamics of large models. We all know the type of error that can be made by following the advice of a very simplistic Keynesian model. I think that we can also make big mistakes following the advice of very simplistic monetarist models. For example, in a simplistic Keynesian model, supply can accommodate every demand shock with limited price increases; on the other hand, in the simplistic monetarist model potential output is exogenous and only nominal shocks have a permanent effect.

A good example of the deficiencies of simple monetarist models is provided by consideration of the possible endogeneity of potential output. Variations in real and nominal interest rates caused by monetary restraint have an effect on investment, on the stock of capital and, accordingly, on potential output. If the reduction of demand is followed by the reduction of supply, the gap in the Phillips curve will become much smaller than was originally thought. In response to such considerations, some economists of monetarist persuasion are in fact doing now what Keynesians were doing 15 years ago; that is to say, complicating their basic model in order to be able to answer such questions. To put the same point differently, if we believe it is important to explain the behaviour of all sectors of the economy, to simulate the behaviour of a series of specific institutions, and to model the various rigidities which seem to exist in the world, then we are implicitly raising objections to the validity of the basic hypothesis used in ultra-simplistic reduced form models. I hope that model builders will share their views on this subject today.

I would like to conclude by saying that our models are poorly equipped to deal with two highly debated questions: the cost of inflation and the effects of the size of the government sector on private sector productivity. An appropriate answer to those two questions necessitates direct links in our model between long-term productivity and the rate of inflation and government activity.

Conclusion

I hope that today's discussion will help us to obtain a better understanding of the dynamics of our models and that it will help us build better models. I would like finish my presentation by repeating the questions I raised previously:

1) How is supply determined in our models?

2) Can we generate bottlenecks?

3) Is the demand for production factors consistent with the production function?

4) Does the supply-demand imbalance in product and labour markets affect prices?

5) Does the price, wage, exchange rate bloc have the properties of an accelerationist model? If not, why not?

6) What are the monetary channels, and what is the role played by expectations in future monetary growth?

OVERVIEW OF THE COMPARATIVE MODELS SEMINAR

Dennis C. Featherstone
Department of Finance

The purpose of my remarks is to stimulate discussion on the reasons for significantly different simulation results. Given the limitations on time, I would like to review the results for three shocks using a series of charts to highlight the results.

Government Expenditure Shock

The first shock I would like to look at is a $1 billion increase in federal current non-wage expenditure, with the spending growing over time with its deflator. The resulting increase in the federal deficit was to be financed through debt, the money supply was to be kept exogenous and the exchange rate endogenous. As can be seen on the first chart, the impact on output as shown through the real expenditure multipliers indicates a general adherence to the expected pattern of a declining trend in the multipliers beyond the early period of the simulation. Two peculiarities in the results can be observed in the first chart:

1) in the case of DRI, the multiplier begins an upward trend in the fourth year of the simulation and continues to rise; and
2) the two models from the Bank, RDXF and SAM, and FOCUS exhibit the downward trend but their curves are well below those for the other models.

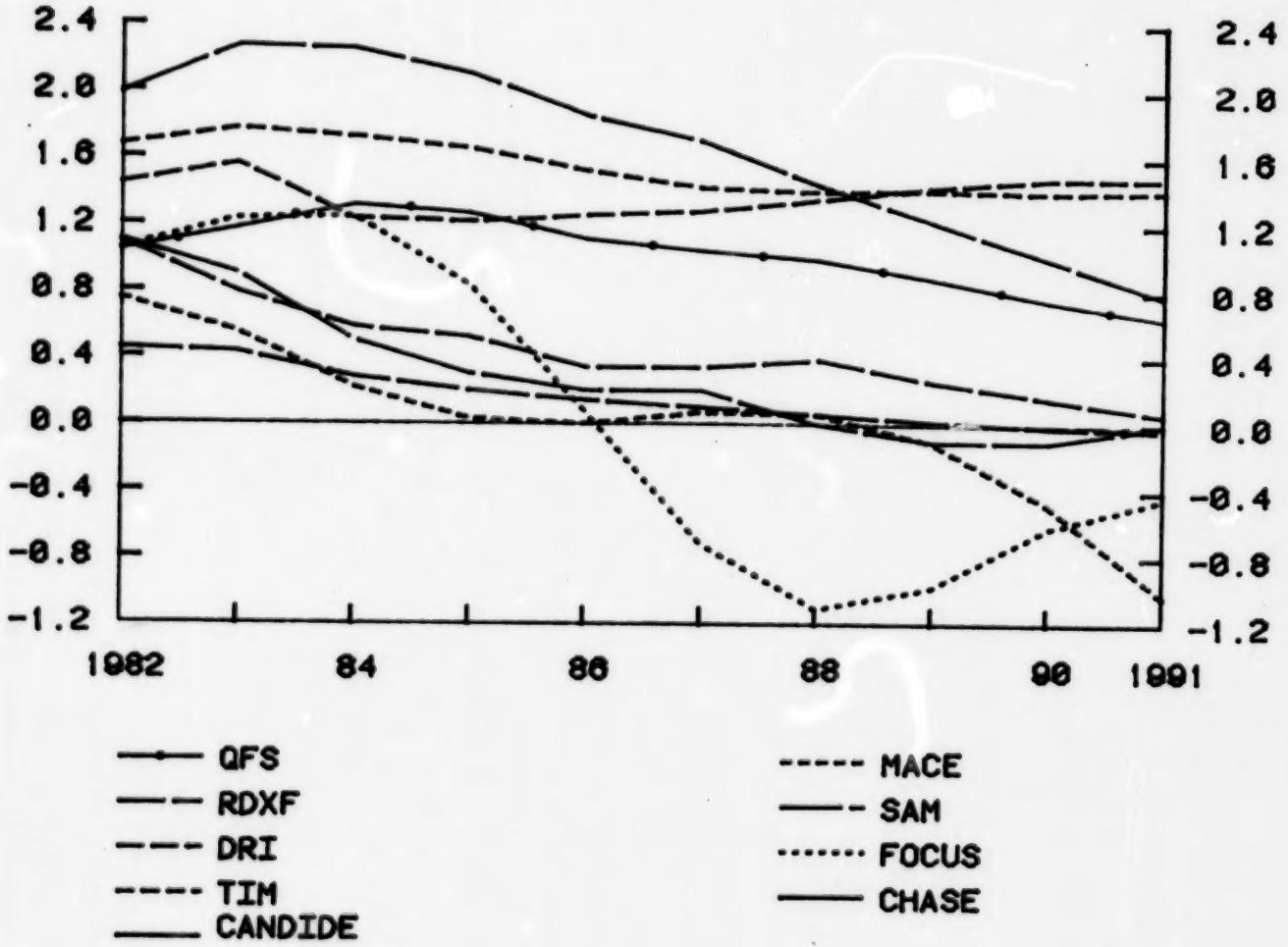
One characteristic of this shock is that it is non-accommodating which raises the question of whether investment is crowded in or crowded out. A separate set of calculations revealed that five model simulations showed declines in real private fixed investment by the seventh year and three showed increases, suggesting no clear answer to the question.

A comparison of the impact on the current account balance reveals two general types of response--after 10 years, there is

Chart 1

REAL EXPENDITURE MULTIPLIERS

(Non-accommodating multipliers)



either a relatively large deterioration or little change. Generally one would expect import leakage, in part determined by the investment response--yet SAM has a favourable impact on the current account through the 10-year period. Both QFS and DRI have little impact on the current account despite the stimulus to demand. I would ask the representatives from SAM, QFS and DRI to comment on these patterns.

A third feature of this shock is the impact of the policy on the federal balance. By the 10th year, the negative impacts range from less than $400 million in FOCUS up to $3 billion in five of the other models; in CANDIDE, however, the deficit rises to $6 3/4 billion. I would like to ask the CANDIDE group why their model might give rise to such a large increase in the deficit. Our monitoring of the CANDIDE simulation suggests that a major part of the answer may be the method used to calculate the interest on the public debt.

Interest Rate Shock

The second shock I would like to comment on is a 100 basis point reduction in short-term interest rates (90-day finance company paper rate). In this shock, the money supply remains endogenous as do all other interest rates. The behaviour of the exchange rate is of considerable interest: four models indicate virtually no change in the rate after 10 years; three indicate a modest deprefciation, and one (FOCUS) indicates a substantial depreciation (after 7 years). As displayed in Chart 2, the output responses generally show a narrow range of increase for the first three years and then oscillating patterns within a wider range through year 10. There are two exceptions to this pattern--the large increase in output shown by FOCUS and the path shown by SAM--a downward trend with a decline in output by 1985. These two patterns need some explanation during the day.

The response of the GNE deflator is shown in Chart 3. FOCUS shows a large increase, presumably due to its estimate of the exchange rate. SAM shows a surprisingly large increase given

Chart 2

IMPACT ON REAL GNE OF 100 BASIS POINT REDUCTION IN SHORT TERM INTEREST RATES

(Shock minus control as a percentage of control)

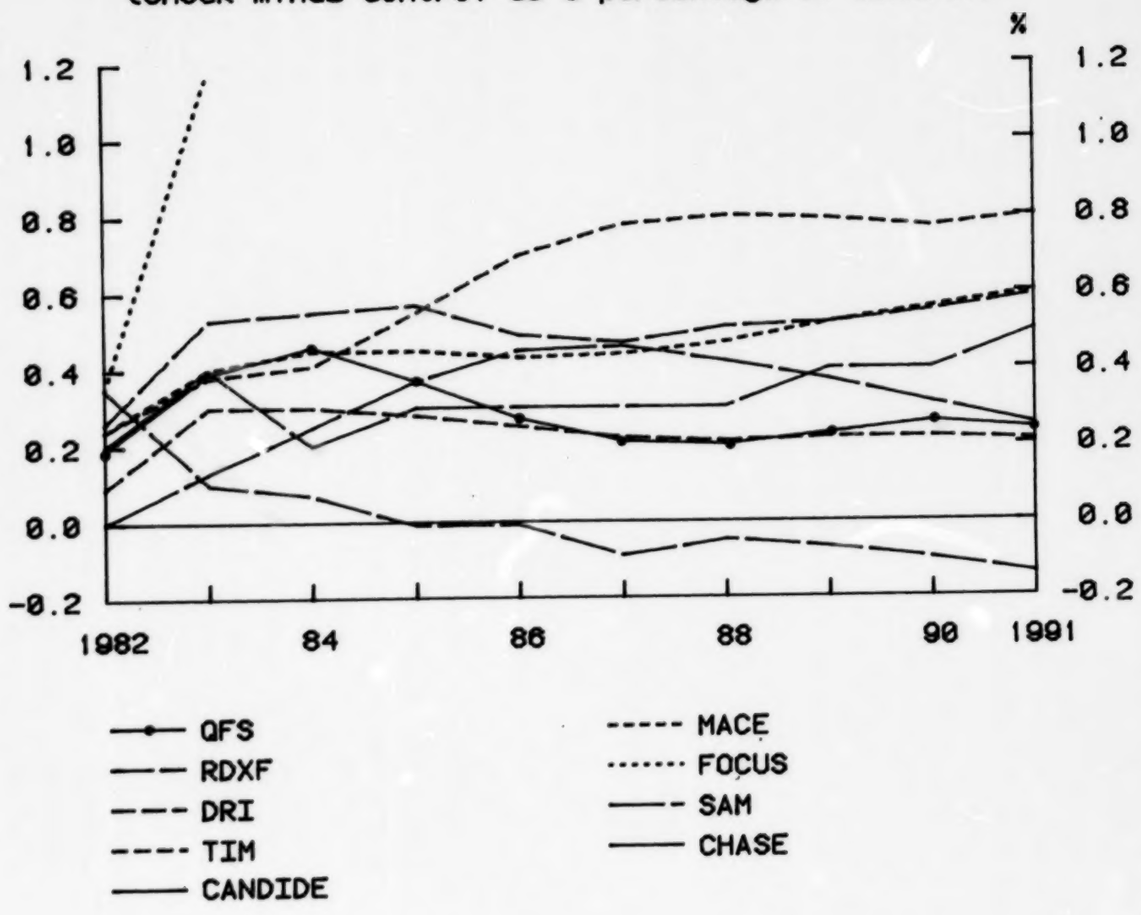
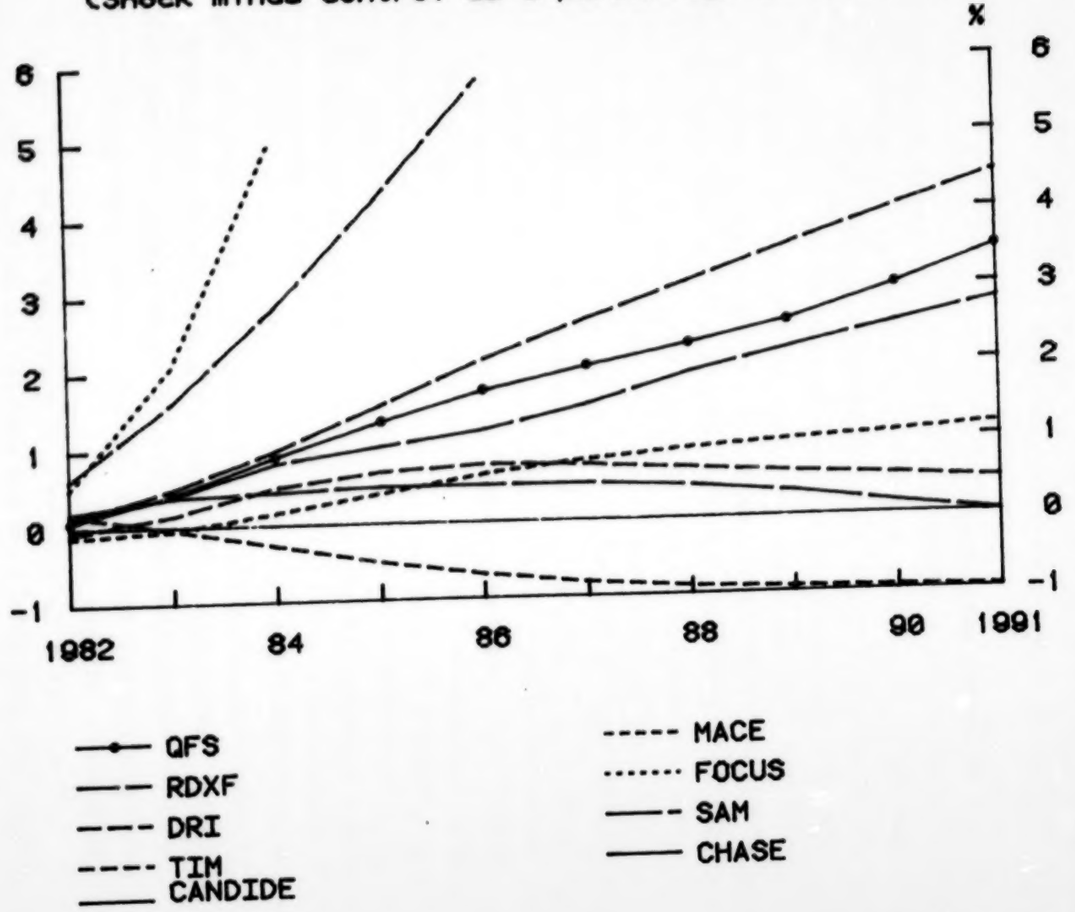


Chart 3

IMPACT ON GNE DEFLATOR OF 100 BASIS POINT REDUCTION IN SHORT TERM INTEREST RATES

(Shock minus control as a percentage of control)



the small change in the exchange rate through the medium term. On the other hand, TIM shows a downward impact on the deflator after the first year. I would ask the representatives from SAM and TIM to comment on these patterns.

Exchange Rate Shock

Given the considerable attention now being focussed on the Canadian dollar, I would like to review the model simulations of an optional shock that six modellers performed--a permanent 10 per cent depreciation of the Canadian dollar by inverting the exchange rate equation to solve for short-term interest rates consistent with the lower value of the dollar. This is essentially a monetary shock that parallels the interest rate reduction shock. In the interest rate shock, interest rates were reduced by an identical sustained amount across models while differences in the model structure led to varied exchange rate impacts. In this shock, the exchange rate depreciation is identical across models, while the reduction in interest rate levels (and monetary expansion) that would bring about this depreciation will differ from model to model. It might have been interesting to have carried out a "partial" shock in which interest rates were held at control, thus facilitating a cross-model examination of exchange rate impacts on the economy in isolation from the differential interest rate impacts. Nevertheless, this shock does highlight the differences in exchange rate impacts arising out of the differences in the models' structures. The benefits and costs of pursuing a monetary policy that would result in an identical rate of depreciation are made more explicit in the cross-model comparisons of this shock.

There was a fair degree of unanimity among the CANDIDE, FOCUS, and QFS models on the decline in interest rates required to engineer a depreciation of 10 per cent (575 to 668 basis points). At the same time, there are two questions that should be addressed. Why do the CANDIDE and DRI models exhibit a

pattern of smaller interest rate reductions in the medium term and progressively large reductions over the longer run? (Given the rise in the domestic price level and its accompanying impact on competitive position, one might not have expected progressively greater reductions in interest rates to maintain the depreciation.) Why do interest rates rise over part of the simulation period in SAM?

Turning to Chart 4, which displays the impact of the shock on the CPI, we can observe several important differences in the responses of the models. The first-year impact on the CPI level differs considerably across the models, ranging from 1.1 per cent in DRI to 5.6 per cent in FOCUS. One judge of the appropriate size of the initial response is the directly imported component of the CPI, which is about 17 per cent. A response greater than 1.7 per cent suggests either a fast wage-price interaction or unique features in the impact of the depreciation on all domestic prices. I would ask FOCUS representatives to indicate the reason for the relatively large first-year impact. Over the medium term, the sharp upward pattern of SAM requires some elaboration. Over the longer run, the positive supply response from lower interest rates should lead to a decline in the inflation rate. Would the QFS and FOCUS representatives indicate why their models show the opposite pattern?

The estimated impacts of the exchange rate shock on the current account are compared in Chart 5. As you know, there is a long list of standard questions to ask in evaluating this shock. Is the depreciation fully or partially reflected in export prices? What is the response of the volume of exports? What is the timing and strength of the response of the volume of imports to the change in relative prices? What is the response of domestic prices? Do the models exhibit a J-curve response of the current account balance over the simulation period? I will restrict my remarks to the J-curve question. One observation from the chart is that only three models indicate a widening of the current account in the initial period. Two of these (FOCUS

Chart 4

IMPACT ON THE CPI OF A TEN PERCENT
EXCHANGE RATE DEPRECIATION VIA MONETARY ACCOMODATION
(Shock minus control as a percentage of control)

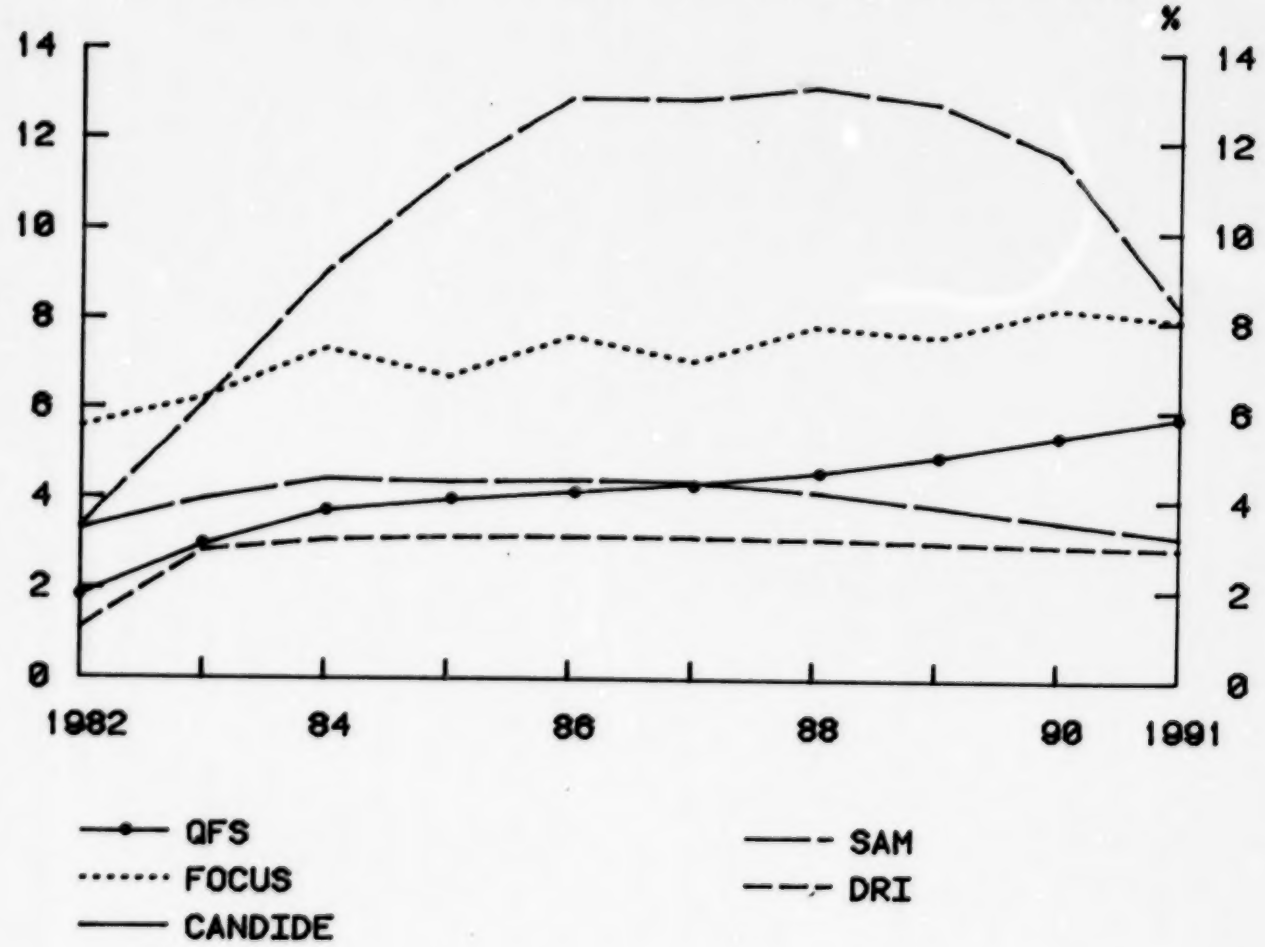
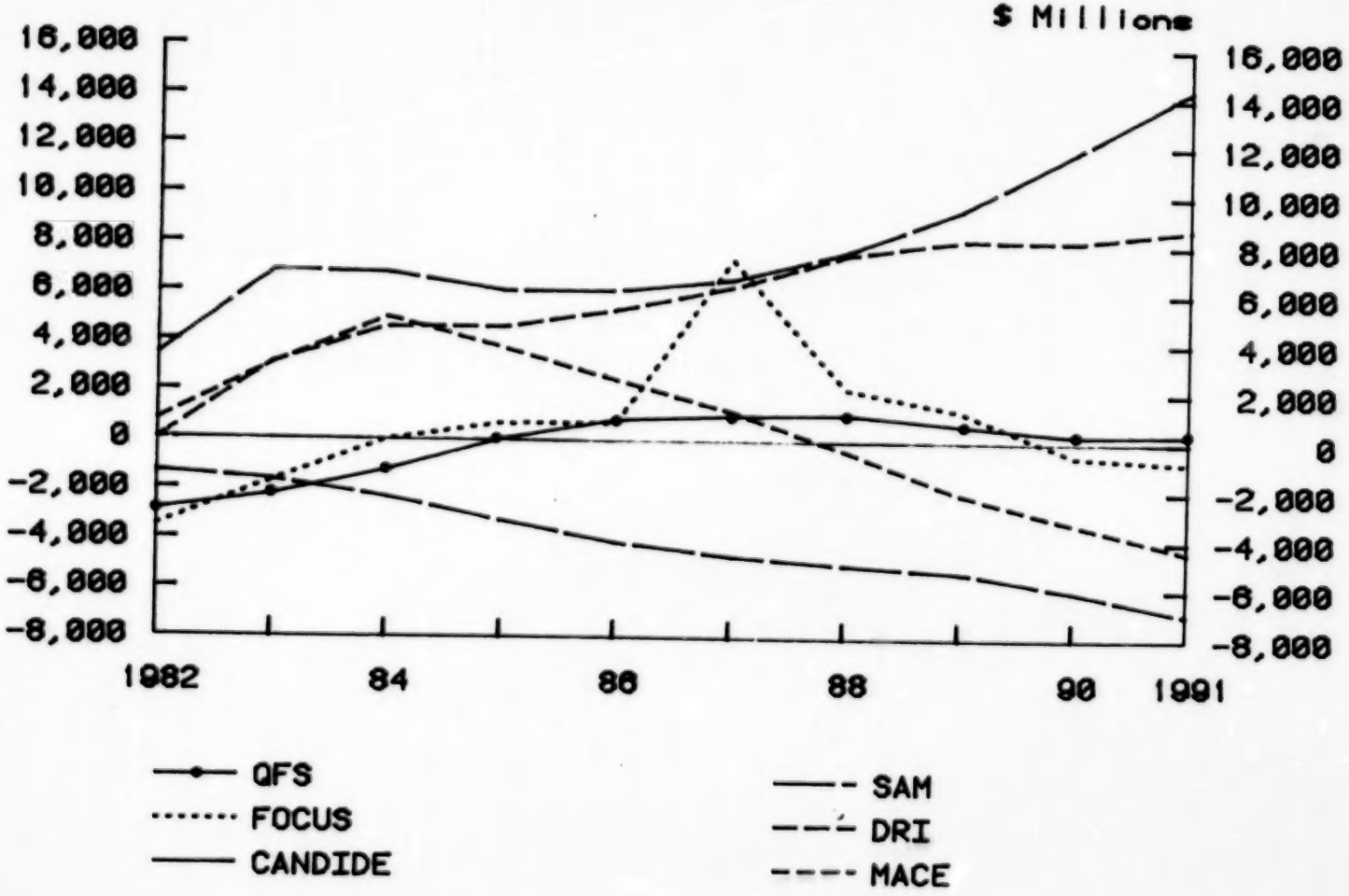


Chart 5

IMPACT ON THE CURRENT ACCOUNT BALANCE OF A TEN PERCENT EXCHANGE RATE DEPRECIATION VIA MONETARY ACCOMODATION

(Shock minus control)

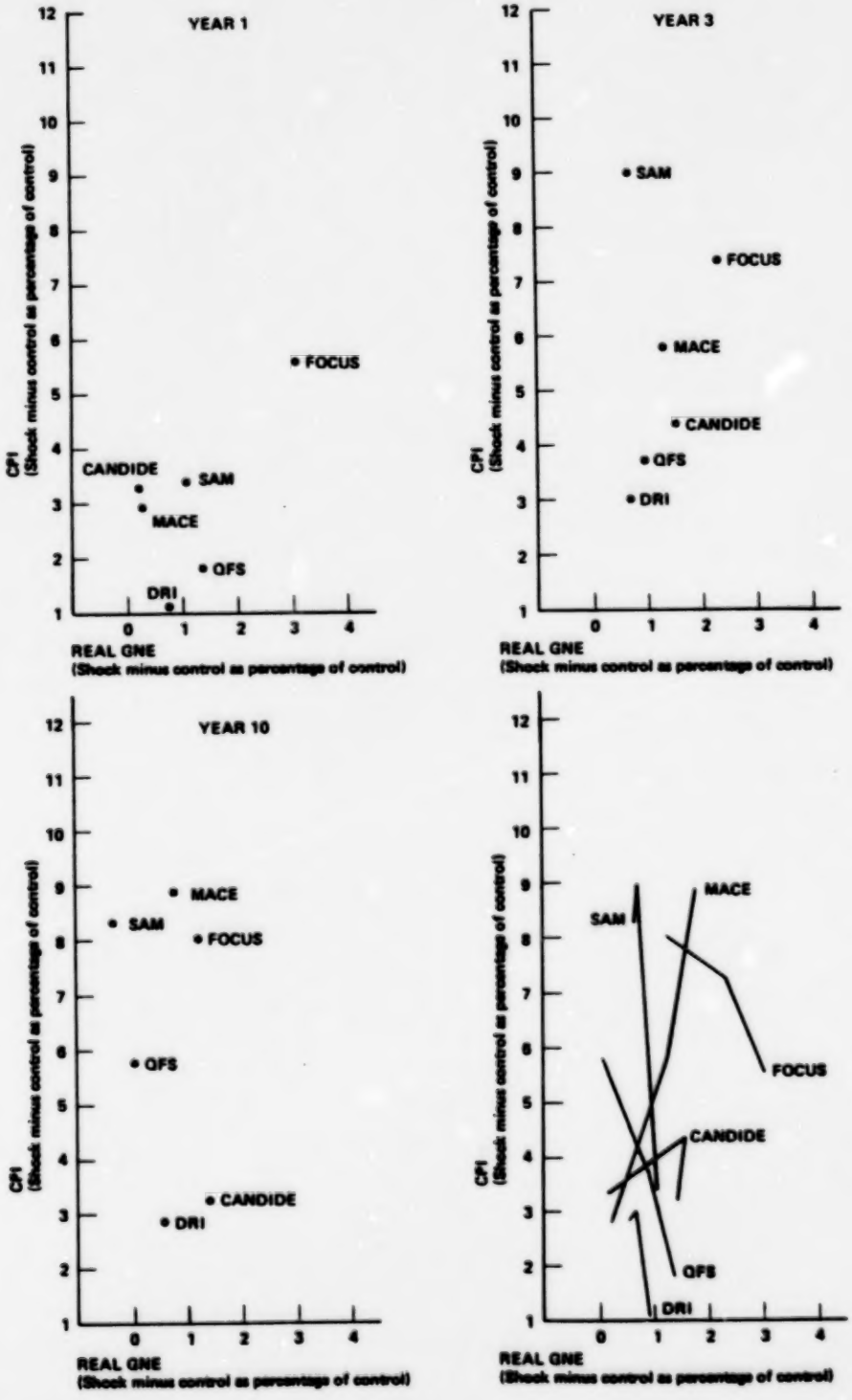


and QFS) then suggest a J-curve response at least through the next 5 years. In SAM, however, the deficit begins to widen again after the second year, suggesting a truncated J-curve. Based on the responses shown in the chart, I would like the SAM representatives to indicate why their model suggests very little if any improvement in the current account balance over the 10-year period.

While Chart 5 shows a generally positive stimulus to the economy through the trade side, there are of course other forces at work. Rising domestic prices depress real disposable incomes and choke off final domestic demand, which countervails the stimulative effect of increased net exports. Lower interest rates, however, serve to stimulate the domestic sector. These several forces make it difficult to factor out and compare the impact of a depreciation. As a total impact, one can look at price-output tradeoffs (Chart 6). For this purpose, as a final comparison, four graphs showing the price-output tradeoff for this shock are set out together. The graph in the upper left corner shows the impact on the first year--DRI shows price and output responses of about 1 per cent while FOCUS shows large increases in both prices and output. In the upper right graph, the impact after the third year is shown. While DRI and FOCUS continue the basic message at the end of the first year, SAM suggests a very large impact on prices with the impact on output having declined to near zero. In the lower left graph, the medium-term results continue to hold. In the lower right graph, the three previous observations are plotted as a trade-off curve. These curves should be backward sloping but we find that MACE and CANDIDE are exceptions although not in a common way. I would ask the MACE and CANDIDE representatives to comment on these graphs.

Chart 6

PRICE-OUTPUT TRADE-OFF



APPENDIX B

LIST OF SEMINAR PARTICIPANTS

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